THE BULLETIN
OF THE
AMERICAN CERAMIC SOCIETY

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OCTOBER • 1934

VOLUME 13 NUMBER 10

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Table of Contents

VOLUME 13 OCTOBER, 1934 NUMBER 10

Editorials 255

Classification as Engineers of Graduates of Collegiate Ceramic Schools 261
Identification of Crystalline Substances by Means of the Petrographic Microscope—By T. N. McVay 255
Importance of Ceramic Trade Papers to Ceramic Progress 261

Papers 262

New Navy Simulative Service Test—By Gregory L. Rogers 262
Problems of Handling Air in the Ceramic Industry—By R. R. Robinson 266
Uses of Sodium Silicates in the Ceramic Industries—By William Stericker 264
Values Derived from High-School Ceramics—By Arnold Bookheim 271

Activities of the Society 275

American Ceramic Society Defends Ceramic Engineering Departments 281
Buffalo Executive Committee for 1935 Annual Meeting Working Fast 285
Committee B Nominates Officers for 1935–1936 286
Enamel Division Committee Announced 286
Glass Division Summer Meeting Attended by More Than 100 (photograph) 287
Glass Division Summer Meeting Roster 288
Glass Division Summer Meeting Roster Reveals Membership Prospects 284
How to Obtain Uniform Thermal Treatment—By Ralph A. Sherman 275
Iowa Ceramists See Value of Uniform Thermal Treatment 280
Los Angeles Women's Club Sponsors Ceramic Lectures 288
Lovejoy Makes Suggestions for Ceramic Ware Firing Symposium 278
Necrology: Carl B. Harrop 274
New Members 284
Productiveness of Carl B. Harrop 286
Reasons Given for Membership and Advertising Push 284
Richardson Discusses Means of Firing Ceramic Ware 279
Robson Discusses Ceramic Ware Firing 276
Roster Changes for September 282
Watch Them Get on Board 284
White Wares Division Selects Nominees for 1935–1936 286

Notes and News 289

Bibliography for the Study of American Glass—By Anna Lane Dixon 289
Erratum 289
Foundry Congress to Hear Renowned Scientists 289
Glass Manufacturers Exhibit American Ware in Iowa 289
Illinois Conference Tentative Program Announced 290
Ohio Ceramic Industries Association Fall Meeting Program 290
Penn State Ceramics Advisory Committee Personnel Announced 289
Primitive Glassworking Demonstrated at Fair 290

Advertisers' Index 11

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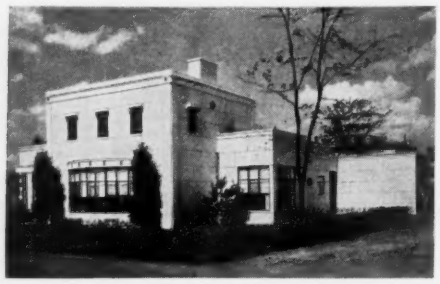

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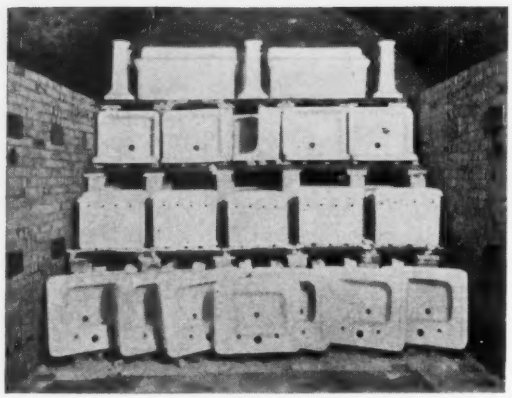

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EDITORIALS

IDENTIFICATION OF CRYSTALLINE SUBSTANCES BY MEANS OF THE PETROGRAPHIC MICROSCOPE*

By T. N. McVay

I. Introduction

It is not the purpose of this paper to discuss the means of measuring optical properties of crystalline solids, but the following scheme for the identification of crystals is presented.

It is the writer's purpose to define roughly the field of use of the petrographic microscope, to summarize briefly the results which have been obtained by microscopic methods, and to offer a few suggestions for possible improvement of technique.

In discussing the crystalline state of matter, the important methods are considered which are available for the differentiation of the crystalline from the amorphous state and to show changes which take place in either when subjected to heat.

It is often difficult to draw the line between true solutions and the colloidal state and almost as difficult to differentiate between crystalline and amorphous aggregates. It is not altogether improbable that there is a third state which may be a transition state between these, which has been designated as the smectic state of matter. In such a state, it can be conceived that there is an orientation in one direction as in the so-called "brush heap" structure of true jellies.

To identify or show changes in the crystalline state of matter, use is made of some physical property or some physical change in matter. Some of these properties are optical properties, X-ray patterns, thermal expansion, heating and cooling curves, specific gravity, and heat of solution.

Among these, the optical methods are probably of the greatest value on account of the definite optical properties of minerals, the ease and rapidity of determinations, the low cost of making microscopic examinations, and the mathematical exactness of the laws of crystallography and optical mineralogy.

To determine whether an unknown material is crystalline, it must have some crystalline characteristic, such as cleavage, or show some optical property, such as double refraction, not solely due to strain such as present in unannealed glasses. It should be recalled that those minerals crystallizing in the isometric system are isotropic to light passing through them irrespective of crystallographic orientation or, in other words, are dark when viewed between crossed-nicols in all positions of rotation of the stage of a petrographic microscope. Amorphous material such as glasses and resins free from strain are also isotropic; consequently, refraction methods alone will not differentiate the amorphous from the crystalline. Reliance must be placed on crystallographic outlines or cleavage, as in fluorite, or on regularly oriented inclusions, as in leucite, and in the fact that glasses break with a conchoidal fracture. An X-ray examination will reveal the true crystalline structure of those minerals crystallizing in the isometric system.

To identify unknown crystalline substances with a petrographic microscope, the lower limit is usually considered to be five microns, or 0.005

* Presented in the Symposium on Crystalline Substances in Refractories, Annual Meeting, American Ceramic Society, Cincinnati, Ohio, February 13, 1934 (Refractories Division). Received May 23, 1934.

SCHEME FOR IDENTIFICATION OF MINERALS†

- **Polarizer only in position. Parallel light**
  - **Opaque** — Use a magnetized needle for iron compounds; notice luster in reflected light; try microchemical tests for Ti, Mn, and S
  - **Non-opaque parallel polarized light; nicols crossed**
    - **Isotropic** — Minerals belonging to the isometric system
      (1) Determine index of refraction
      (2) Color
      (3) Cleavage
      (4) Hardness
      (5) Chemical Tests
    - **Anisotropic; crossed-nicols convergent light; interference figure**
      - **Uniaxial Test for positive or negative sign**
        - Tetragonal or hexagonal. Can not usually be distinguished with grains
        - **Uniaxial positive**: (1) Measure index of ω ray; (2) Measure index of ϵ ray; (3) Note color and pleochroism; (4) Note cleavage
        - **Uniaxial negative**: (5) Hardness; (6) Chemical tests
      - **Biaxial Test for positive or negative sign**
        - Orthorhombic, monoclinic, or triclinic; can sometimes be distinguished with grains by means of extinction angles, or rarely the dispersion of the interference figures can be determined
        - **Biaxial positive**: (1) Determine β index; (2) Note birefringence; (3) Note color and pleochroism; (4) Estimate size of optic angle; (5) Note extinction parallel or inclined; (6) Measure extinction angle
        - **Biaxial negative**: (7) Determine sign of elongation; (8) Measure γ and α; (9) Note twinning; (10) Hardness; (11) Chemical tests

† T. N. McVay, An Introductory Text to Optical Mineralogy, University Supply Store, University, Ala.

millimeter, in case all the optical properties are to be obtained. In studying devitrification phenomena in glasses of which the constitution diagrams and chemical analyses are known, particles as small as two microns can often be identified, as these are large enough for the determination of extinction angles, sign of the elongation, and for at least a rough approximation of the index of refraction. Particles as small as 0.2 micron can be seen with the microscope. To the layman who does not have a conception of the size of atoms and molecules, these may appear to be small particles. However, if one considers the crystalline state of matter as originating in the orientation of molecules and atoms in a three-dimensional unit cell, a micron is a large dimension; for instance, the unit cell of sodium chloride is a cube, 5.628 Ångström units in external dimensions, the Ångström unit being only one ten-thousandth of a micron. Thus for the critical examination of the crystalline state below the limit of approximately 5 microns, the use of X-rays is invaluable. With particles 5 microns in size, the use of the petrographic microscope is indicated. However, when dealing with opaque matter the petrographic microscope is at a disadvantage, and then recourse must be taken to chemical analyses, to the use of X-rays or to metallurgical methods. The latter have been developed for the examination of ore minerals by Short[1] and others. Metallographic methods have been used by Sosman for a study of slags and refractories.

II. X-Ray Methods

When working with X-ray diffraction patterns, we must have a rather pure material as it is difficult to unravel patterns because of a multiplicity of lines when more than two crystalline substances are present in a sample. If a small amount of an impurity is present, the lines of this impurity will be weak, as it is necessary to have a sufficient amount of a finely divided mineral present to produce well-defined lines by the powder method. Also, since in quantitative work, it is necessary to judge the amount of the impurity present by the intensity of the lines which it produces, large errors may result.

In addition, the cost of the X-ray apparatus is high, and it is consequently not available to a large number of research laboratories.

With a microscope, a large number of minerals

[1] M. N. Short, *Geol. Surv. Bull.*, No. 825.

may be dealt with at one time, as in the examination of the heavy minerals in a sea sand or glass sand, where ten or more minerals may be present in a sample.

EDITORIAL NOTE: The problem may be simplified by first making a centrifugal separation using oils of suitable density. The reader is requested to note footnote references 2 to 9, the text for which has been omitted.

A detailed discussion of the methods of thermal expansion measurements, heating and cooling curves, heat of solution determinations, and specific gravity measurements is outside the scope of this paper. It need only be remarked that these methods give an indication of some change, and it requires, in most cases, a microscopic or X-ray determination or, in cases of dissociation, a chemical analysis to determine what has taken place.

A brief résumé of some of the results that have been obtained by the use of the petrographic microscope should be of general interest.

III. Raw Materials

The work of McCaughey,[10] Galpin,[11] Somers,[12] Schurecht,[13] McDowell,[14] Ross,[15] Shannon,[16] Kerr,[17] Grim,[18] and Möhl,[19] has, by means of chemical analyses and petrographic and X-ray examinations, given a clearer understanding of the nature of the clay minerals, particularly, kaolinite, dickite, nacrite, anauxite, montmorillonite, beidellite, and halloysite. The recent work of Grim[18] on the mineral constituents of fuller's earth is particularly interesting as he found that a large number of these earths were primarily constituted of montmorillonite.

IV. Phase-Rule Diagrams

The usual methods employing cooling curves are not, in general, applicable to the determination of the freezing or melting points of silicates. The use of the petrographic microscope has made these diagrams possible, and they in turn have made possible the better understanding of glasses, glazes, refractories, slags, whiteware bodies, and cements.

NOTE: For much of this work we are indebted to the research staff of the Geophysical Laboratory of the Carnegie Institution of Washington which has been a leader in the study of phase-rule relations of the silicates. Considerable work has been done also by Bunting and others at the Bureau of Standards.

When we are able to obtain data on the viscosity relationships in these systems at high temperatures, we shall have gone a long way toward the solution of many of our ceramic problems.

V. Dissociation of Silicates

The work of Peck,[20] Insley, Bowen, and Wyc-

[2] A. E. R. Westman, "Thermal Expansion of Fireclay Brick," *Univ. Ill. Eng. Expt. Sta. Bull.*, No. 181.

[3] Robert B. Sosman, The Properties of Silica, American Chemical Society Monograph Series, The Chemical Catalog Co.

[4] T. N. McVay and C. L. Thompson, "X-Ray Investigation of the Effect of Heat on China Clays," *Jour. Amer. Ceram. Soc.*, **11** [11], 829–41 (1928).

[5] R. A. Heindl and W. L. Pendergast, "Fire Clays, Some Fundamental Properties at Several Temperatures," *ibid.*, **13** [10], 725–50 (1930).

[6] F. Neumann, *Z. anorg. allgem. Chem.*, **145**, 193–238 (1925); *Ceram. Abs.*, **4** [12], 358 (1925).

[7] A. B. Peck, "Changes in the Constitution and Microstructure of Andalusite, Cyanite, and Sillimanite at High Temperatures and Their Significance in Industrial Practice," *Jour. Amer. Ceram. Soc.*, **8** [7], 407–29 (1925).

[8] J. W. Greig, "Formation of Mullite from Cyanite, Andalusite, and Sillimanite," *ibid.*, **8** [8], 465–85 (1925).

[9] J. M. Knote, "Chemical and Physical Changes in Clays Due to the Influence of Heat," *Univ. Ill. Dept. of Ceram. Eng. Bull.*, No. 15.

[10] W. J. McCaughey, "The Mineralogical Examination of Clays," *Trans. Amer. Ceram. Soc.*, **15**, 322 (1913).

[11] S. L. Galpin, "Studies of Flint Clays and Their Associates," *ibid.*, **14**, 301 (1912).

[12] R. E. Somers, "Microscopic Examination of Clays" (from High-Grade Clays of the Eastern United States), *U. S. Geol. Surv. Bull.*, No. 708, pp. 292–305.

[13] H. G. Schurecht, "Microscopic Examination of the Mineral Constituents of Some American Clays," *Jour. Amer. Ceram. Soc.*, **5** [1], 3 (1922).

[14] J. S. McDowell, "Mineralogy of Clay," *ibid.*, **9** [1], 55 (1926).

[15] C. S. Ross and E. V. Shannon, "The Minerals of Bentonite and Related Clays, and Their Physical Properties," *ibid.*, **9** [2], 71–90 (1926).

[16] E. V. Shannon, "Notes on the Mineralogy of Three Gouge Clays from Precious Metal Veins," *Proc. U. S. Nat. Mus.*, No. 62, Art. 15 (1923).

[17] (*a*) C. S. Ross and P. F. Kerr, "Kaolin Minerals," *Jour. Amer. Ceram. Soc.*, **13** [3], 150–60 (1930). (*b*) "The Clay Minerals," *ibid.*, **16** [1], 57–58 (1933). (*c*) *U. S. Geol. Surv. Professional Paper*, No. 165, pp. 151–76 (1931).

[18] R. E. Grim, "Petrography of the Fuller's Earth Deposits, Olmstead, Illinois, with a Brief Study of Some Non-Illinois Earths," *Econ. Geol.*, **28** [4], 344–63 (1933).

[19] (*a*) H. Möhl, "Microscopic Investigation of Ceramic Raw Materials," *Ber. deut. keram. Ges.*, **10** [2], 105–29 (1929). (*b*) W. H. Fry, "Petrographic Methods for Soil Laboratories," *U. S. Dept. Agr. Tech. Bull.*, No. 344 (10 cents). (*c*) E. S. Larsen and H. Berman, "The Microscopic Determination of the Non-Opaque Minerals," 2nd. ed., *Geol. Surv. Bull.*, No. 848 (20 cents). (*d*) M. N. Short, "The Microscopic Determination of the Ore Minerals," *Geol. Surv. Bull.*, No. 825 (60 cents).

[20] A. B. Peck, (*a*) see reference No. 7. (*b*) "Dumortierite as a Commercial Mineral," *Amer. Mineral.*, **11** [4], 96–101 (1926). (*c*) "The Behavior of Unstable or Monotropic Forms in the System Alumina–Silica and Related Systems," *Jour. Amer. Ceram. Soc.*, **16** [1], 68–75 (1933).

koff,[21] Greig,[22] Fenner,[23] and others has given an insight into the changes involved in the transformation of silica, clay, and the alumina-silica minerals into other minerals. The work of Carstens and Kristofferson,[24] and McDowell and Howe[25] on the changes taking place during the heating of magnesite belong in this category. Mention should also be made of the contributions of Bigot,[26] Rhode and Harkort,[27] Barlett,[28] and Phelps[29] on alumina, bauxite, and diaspore. In some instances, the X-ray has been used to supplement microscopic methods with valuable results.

VI. Reactions in Silicates

These are, of course, intimately connected with the phase-rule relations of the silicates, and, providing the chemical composition is known, a clue to the end products of reactions may be deduced.

The researches of Simpson[30] and McDowell and Lee[31] on the action of coal-ash slags on refractories, the work of McLellan[32] on lead and copper furnace slags, and the work of Insley[33] and Sosman[34] on corrosion of glass tanks has yielded valuable information. Trostel,[35] in a recent article, has pointed out the practical use of the microscope for plant control in connection with melting furnaces for studying reactions taking place at high temperatures and points out the sometimes neglected fact that the phases present at high temperatures are not the same as those present in slowly cooled melts. The recent work by Heindl[36] on refractories and by Seil[37] on chrome refractories should not be overlooked. Riddle and Peck[38] have made a noteworthy study concerning the effect of heating refractories for long periods in tunnel kilns.

Problems on which we have little data are the reactions taking place in the refractories of Portland cement kilns, the reactions with chrome, diaspore, fused alumina, and silicon carbide when acted upon by fluxes, and particularly the reactions occurring in sulfate recovery furnaces where the slagging action of sodium salts is particularly severe.

Although not directly in the field of refractories, the work of Klein,[39] Norton,[40] Peck,[41] and Insley[42] on whiteware should be noted. There is a vast amount of unpublished work on ceramically bonded fused-alumina and silicon carbide grinding wheels and the effect of heat on these materials.

VII. The Microscope as an Aid to the Analyst

The microscope is a distinct aid to the analyst. If a chemist is given an unknown mineral for analysis he has ninety-two elements to consider. With the aid of the microscope he can, in most cases, narrow the possibilities of the elements present and can determine his analytical procedure more rapidly. In some cases a microscopic examination will save an analysis as in the detection of such impurities as quartz, tourmaline,

[21] N. L. Bowen and R. W. G. Wyckoff, "Thermal Dissociation of Dumortierite," *Jour. Wash. Acad. Sci.*, **16** [7], 178–89 (1926).

[22] J. W. Greig, see reference No. 8.

[23] C. N. Fenner, "Stability Relations of the Silica Minerals," *Amer. Jour. Sci.* [4], **36**, 383 (1913). See also "Symposium on the Physical Chemistry of the Alumina–Silica Refractories," *Jour. Amer. Ceram. Soc.*, **16** [1], 54–76 (1933).

[24] C. W. Carstens and K. R. Kristofferson, "Study of the Petrography of Magnesite Brick," *Norsk. Geol.*, **10**, 1–13 (1928).

[25] J. S. McDowell and R. M. Howe, "Magnesite Refractories," *Jour. Amer. Ceram. Soc.*, **3** [3], 185–247 (1920).

[26] A. Bigot, "Fused Kaolins and Bauxites," *Compt. rend.*, **178** [6], 569–71 (1924).

[27] I. Rhode and Hermann Harkort, "Microscopic Examination of Ceramic Raw Materials and Fired Products," *Jour. Amer. Ceram. Soc.*, **15** [3], 179–87 (1932).

[28] Helen B. Barlett, "Occurrence and Properties of Crystalline Alumina in Silicate Melts," *ibid.*, **15** [7], 361–64 (1932).

[29] S. M. Phelps, "A Study of the Shrinkage of Diaspore Clays," *ibid.*, **9** [10], 659–67 (1926).

[30] H. E. Simpson, "An Investigation of the Action of Coal-Ash Slags on Fire Brick by Microscopic Methods," *ibid.*, **15** [10], 520–36 (1932).

[31] S. J. McDowell and H. C. Lee, "Petrographic Study of Slags from Boiler Furnaces," *ibid.*, **11** [1], 35–41 (1928).

[32] Roy D. McLellan, "Petrographic Study of Lead and Copper Furnace Slags," *Amer. Inst. Mining Met. Engrs. Tech. Pub.*, No. 305, Class D.

[33] (*a*) H. Insley, "Notes on the Behavior of Refractories in Glass-Melting Furnaces," *Jour. Amer. Ceram. Soc.*, **7** [8], 583–94 (1924). (*b*) "Determination of the Source and Means of Prevention of Stones in Glass," *ibid.*, **12** [3], 143–52 (1929).

[34] R. B. Sosman, "Some Fundamental Principles Governing the Corrosion of a Fireclay Refractory by a Glass," *ibid.*, **8** [4], 191–205 (1925).

[35] L. J. Trostel, "Petrographic Methods Applied to Ceramic Research," *Ceram. Age*, **22**, 177–78 (1933).

[36] R. A. Heindl, "Thermal Expansion of Refractories to 1800°C," *Brick Clay Rec.*, **83** [2], 59–62 (1933).

[37] Gilbert E. Seil, "Petrography and Heat Treatment of Refractories" (presented at the Annual Meeting, American Ceramic Society, Cincinnati, Ohio, February, 1934).

[38] F. H. Riddle and A. B. Peck, "An Eighteen Months' High Temperature Test on Refractory Test Specimens," *Jour. Amer. Ceram. Soc.*, **9** [1], 1–23 (1926).

[39] A. A. Klein, "Constitution and Microstructure of Porcelain," *Bur. Stand. Tech. Paper*, No. 80 (1916).

[40] C. L. Norton, "The Influence of Time on the Maturing Temperature of Whiteware," *Jour. Amer. Ceram. Soc.*, **14** [3], 192–206 (1931).

[41] A. B. Peck, "Effect of Time and Temperature on the Microstructure of Porcelain," *ibid.*, **2** [3], 175–94 (1919).

[42] H. Insley, "Microstructure of Earthenware," *ibid.*, **10** [5], 317–26 (1927).

calcite, and rutile in clays; the estimation of free quartz in feldspar by the Klein-Booze method or one of its modifications; the identification of a mineral such as cassiterite in a concentrate or the determination of the possibility of ore-concentration methods. Quantitative results can often be obtained by counting the number of grains of a given mineral in a sample or by making traverses across a thin section and recording the intercepts of each mineral. The filar micrometer eyepiece, the Leitz integrating stage, and the Wentworth recording micrometer are useful for making traverses across thin sections of minerals or for counting grains.

Slawson[43] has devised a method of shortening the J. Lawrence Smith procedure for sodium and potassium by fusing the mixture of the two chlorides and determining the index of refraction of the mixture. He gives 2% as the accuracy of this procedure.

The microscope may also be used for measuring the size of particles, and by the application of statistical methods, the coefficient of variation and thus the accuracy of sizing may be obtained. The filar micrometer is particularly valuable for measuring grain size.

VIII. Thin Section and Immersed Grain Petrography

The older method of thin-section petrography is being supplemented by the method of immersed grains. In the event that structure is to be studied the use of thin sections is generally the more satisfactory as in the case of reactions taking place at the interface between a glass and a refractory. However, if it is desired to identify a crystalline phase the grain method is more suitable, since indices of refraction can be so rapidly measured. The latter is faster and more accurate and no thin section is required. In many instances a great deal can be learned by crushing the refractory, screening the fine particles through a 100-mesh sieve, and examining these to determine the reactions between the bond and the refractory. This method is particularly applicable to the study of ceramically bonded grinding wheels.

The methods of immersed grain petrography are now gaining well-deserved recognition in the field of chemical microscopy and with the data assembled by Winchell,[44] the rapid identification of many inorganic artificial compounds can readily be made. For instance there are a large number of hydrates of mono-, di-, and tri-sodium phosphates and these can easily be differentiated one from the other by optical methods. Not so many data are available when it comes to the identification of organic compounds and the problem is greater on account of the 500,000 known compounds, many of which are crystalline. A large number of these are soluble in the usual immersion media, but there are many which are not, and this opens an unlimited field to the petrographer.

IX. Needs of the Petrographer

Satisfactory immersion oils are available for the range of refractive indices from 1.409 to approximately 1.70. From 1.74 to 1.78 we must rely at the present time on mixtures of sulfur and methylene iodide which, on account of the dark color and lack of constant indices of refraction, are not very satisfactory. Above 1.78, mixtures of solids such as selenium and sulfur are used which are red in color. Other media are mixtures of piperine and arsenic and antimony sulfides. There is need for a better series of immersion media in the upper range. It is possible that some of the organic compounds when brominated or iodated will give satisfactory results. As an instance, brominated diphenyl is colorless and has an index of refraction slightly above 1.71. It is probable that if this material were iodated the index would be above 1.80.

X. Measurement of Indices of Refraction

The usual type of Abbé refractometer will measure refractive indices to 1.70. The Smith hand refractometer will read to 1.78 and estimations can be made to the third decimal place. The Spencer Lens Company has manufactured an Abbé refractometer which will read to 1.84. However, the glass has a high lead content, is easily scratched, is attacked by iodine, and is rather yellow in color. With reasonable care it is suitable for measurements to the fourth decimal

[43] C. B. Slawson, "Quantitative Optical Determination of Sodium and Potassium Chlorides," *Amer. Mineral.*, **14** [8], 293–98 (1929).

[44] A. N. Winchell, The Microscopic Characters of Artificial Inorganic Solid Substances or Artificial Minerals, John Wiley & Sons, New York, 1931.

place. Emmons and Williams[45] have devised a high-index refractometer, the description of which is taken verbatim from their paper:

> A cleavage fragment of smithsonite of known refractive indices is mounted permanently in a hole in a microscope slide. The cavity is filled with liquid of high but otherwise unknown index and covered with a cover glass. The slide is then mounted on a universal stage equipped with a water cell for temperature control. The crystal is rotated in such a way that its principal section remains parallel to the polarizer. When the indices of the crystal and liquid agree, the amount of rotation from the optic axis position is used as the ordinates of a graph. The abscissa gives the refractive index. Proximate curves serve to indicate dispersion.

Since the higher index of smithsonite is 1.818, the instrument can not be used above this figure.

The von Schlichten[46] method consists in placing an auxiliary lens in the slot above the objective. This consists of a glass slide having a concave depression which is filled with the liquid whose refractive index is to be determined and a cover glass placed over it. When this is introduced into the tube of the microscope the focus is changed according to the refractive index of the liquid. It is necessary to calibrate the microscope with five liquids whose refractive indices are known. After the calibration is once made the refractive index for unknown liquids can be determined from the curve which is plotted as refractive index against distance of focus. A 42-millimeter objective is used and the accuracy is given as 0.005. Since the cost of such a slide is very small, this method is particularly useful where no refractometer is available. For high-index media, recourse must be taken to minimum deviation determinations, with the use of a goniometer or by means of a refractometer with a variable refracting angle described by McLellan.[47]

Mention should be made of the new objective devised by Slawson[48] which has a variable diaphragm for the observation of interference figures and is useful for the measurement of the optic angle.

Universal stages have come into more general use but it is unlikely, on account of the high cost of the apparatus and the more difficult technique, that they will displace the ordinary methods of observation which are satisfactory for the identification of minerals and the study of structural relations. Such instruments are exceedingly valuable for the establishment of exact fundamental optical data.

XI. Mounting Media

Canada balsam is rapidly being replaced by "Kollolith" as a mounting medium for thin sections and grains, since the latter is easier to use and the slides are free from bubbles. Both Kollolith and Bakelite are useful for making thin sections of friable materials such as clays. If Kollolith is not available, Canada balsam may be heated until a trial sample hardens when cooled. The balsam may then be dissolved in benzol or xylol and the solution used for mounting, as the solvent rapidly evaporates and leaves the balsam hard and free from bubbles. The solution may also be used for sealing water solutions under cover glasses for crystallization studies. The writer has kept such solutions without evaporation for three months and longer.

Highly chlorinated diphenyl such as Arochlors[49] 4465 and 5460 may also be used for permanent slides. These have an index of approximately 1.65 and consequently make more satisfactory mounts than Canada balsam for those minerals which have high indices of refraction. The material is inexpensive and mounts free from bubbles can be readily made.

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University of Alabama
University, Alabama

[45] R. C. Emmons and E. F. Williams, "A High Index Refractometer" (read before a meeting of the American Mineralogical Society, December, 1933).

[46] Personal communication from Dr. O. C. von Schlichten, Univ. of Cincinnati.

[47] Roy D. McLellan, "The Use of a Refractometer with a Variable Refracting Angle," *Amer. Mineral.*, **18** [4], 133–48 (1933).

[48] C. B. Slawson, "An Objective with a Variable Diaphragm," *ibid.*, **19** [1], 24–28 (1934).

[49] Swann Chemical Company, Birmingham, Ala.

IMPORTANCE OF CERAMIC TRADE PAPERS TO CERAMIC PROGRESS

The courage, wisdom, and business sagacity of the managerial executives of ceramic producing concerns are the vital organs of our economic being. They would, however, soon be impotent if they were not provided with and if they did not assimilate trade and technical information. They can not independently create, digest, and perform all of the physiological functions needed for their informational subsistence. If they are to be at their maximum effectiveness a balanced diet of information must be provided.

In the normal scheme of things there are several sources of information and of those that are devotedly and strictly ceramic in scope we acknowledge our ceramic trade associations, our ceramic trade press, our ceramic materials and equipment concerns, our ceramic schools, and our ceramic research departments in national bureaus, experiment stations, and institutes.

In this set-up is the American Ceramic Society, duly mindful of the importance of all of these informational sources, ever interested and always anxious to promote their well being.

The ceramic trade journals have maintained, indeed improved, their production of timely and worth while information throughout these times of shrunken financial incomes. They have employed the best and most attractive of graphic arts skill. Their productions are attractive in appearance and substantial in content. They are well deserving of subscription support.

Trade directories and catalogs issued by producers of these ceramic journals have value as encyclopedias. These, with the catalogs and circulars from materials and equipment concerns, constitute sources of valuable information not elsewhere furnished.

The last one of the catalogs to come to this editor's office is the Seventh Edition of Ceramic Catalogs on Equipment and Materials with supplementary reference guides to processes in the manufacture of brick, enamel, glass, pottery, refractories, sewer pipe, tile, terra cotta, etc., published by Industrial Publications, Inc., Chicago, Ill.

This catalog has required much patient, painstaking search of the literature for data and editorial skill in assembling and printing. It represents a large investment of time, energy, money, and skill. It is evidence of a strong desire to make readily available very pertinent ceramic information. It should be valued by each ceramic ware producer, ceramic instructor, and ceramic student.

CLASSIFICATION AS ENGINEERS OF GRADUATES OF COLLEGIATE CERAMIC SCHOOLS*

The New York Board of Examiners of Professional Engineers and Land Surveyors defines a professional engineer as one qualified to investigate, evaluate, plan, design, and supervise the construction or operation of buildings, machines, equipment, processes, works, or projects wherein the safeguarding of life, health, or property is concerned.

"Safeguarding" seems to be the idea emphasized. Is "safeguarding" the whole objective of an engineer? Should not the qualification of an engineer be more largely that of ability to evaluate, plan, design, and supervise production of marketable ware under healthy conditions and by profitable means?

Neither are ceramic engineers recognized by the Ohio Board of Examiners. This is serious.

On the basis of safeguarding health it would seem self-evident that if one group of persons is more qualified than another for recognition and registration as engineers it is the ceramic engineer.

Supposedly he is trained to investigate, evaluate, plan, and design and to supervise construction and operations. He produces the artificial teeth, cooking equipment, tableware, lavatories, toilets, urinals, sewer pipe, and sewer brick so necessary to health. He guards the health of his employees. He makes his ware so economically and of such excellent quality that all who will, may buy and use it. What more can one engineer do to safeguard health?

* See this issue, pp. 281–82.

PAPERS

THE NEW NAVY SIMULATIVE SERVICE TEST*

By Gregory L. Rogers

I. Introduction

In order that fire brick be approved by the Navy for use in marine boilers and in boilers for shore service, they must pass the Navy Simulative Service Test.

For control purposes and to assist in developing new refractory products, we recently built the two furnaces required in the new Navy Simulative Service Test.

II. Previous Tests

The old Navy test used previously is described in the *Journal*.[1] One furnace was used in this test. The spalling test consisted merely of turning off the oil and allowing the air to blow into the furnace after the two 24-hour runs at 2900°F and 3000°F were completed.

In the new Navy test more stress is laid on spalling behavior and the spalling test requires a separate furnace.

III. Description of the New Navy Test

The new Navy Simulative Service Test is divided into two parts and is described by the U. S. Naval Boiler Laboratory as follows:

> The first part, a refractoriness test, consisting of two runs of 24 hours each, measures the ability of the testing material to withstand high temperatures without exhibiting softening, fusion, bloating, and volume change, and produces vitrification comparable to that observed after failure in actual service.
>
> The spalling test measures the resistance of the test material to spalling by subjecting it to ten cycles of alternate heating at about 2650°F for 20 minutes and cooling with high velocity air under atmospheric conditions for a like period.

IV. Method of Conducting the Test

The material to be tested is built into steel frames and occupies a space 17½ by 18 inches.

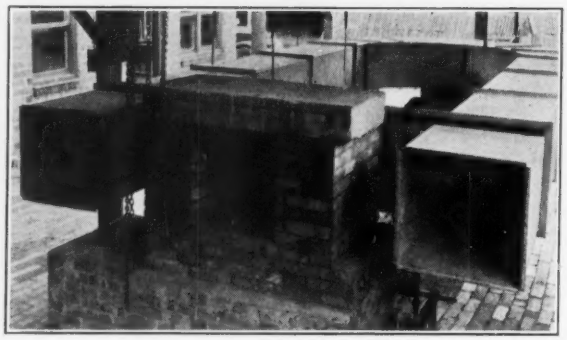

Fig. 1.—Spalling furnace and air ducts.

For brick this would be two stretcher courses seven brick high. The test brick are backed up by 2½ inches of calcined diatomaceous earth brick and 1 inch of uncalcined diatomaceous earth block. The frames containing the built-in test panels are handled by means of a chain block and overhead trolley.

For the refractoriness test the frames are clamped to the sides of the furnace and form the combustion chamber walls.

For the spalling test the frames containing the test panels, which have undergone the refractoriness test, are clamped together side by side to permit them to be shifted simultaneously. While one panel is being heated by the spalling furnace the other panel is being subjected to spalling in front of one of the air ducts.

(1) The Refractoriness Test

In the Navy test the refractory test furnace for marine brick operates at 3000°F for 24 hours, followed by a run at 2900°F for 24 hours; in testing brick for shore service the temperatures are 2900°F and 2800°F for 24 hours, respectively.

The new A.S.T.M. specification will require that the temperature of 3000°F in the refractoriness test shall be obtained in not less than five hours or more than eight hours.

Fuel oil of gravity 12 to 18 Bé is burned in an oil-atomizing burner without preheating. The air pressure is between 50 to 85 pounds per square inch.

* Received December 8, 1933.

[1] (*a*) H. H. Norton and R. L. Porter, "The Method of Selecting Refractories for Marine Purposes of the Navy," *Jour. Amer. Ceram. Soc.*, **7** [7], 575–82 (1924).

(*b*) G. L. Rogers, "Use of the Simulative Test Furnace as a Means of Making Comparative Tests of Fire Brick," *ibid.*, **11** [5], 323–29 (1928).

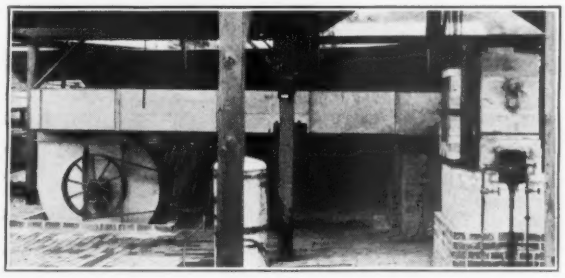

FIG. 2.—End view of refractory test furnace, showing method of clamping frames containing test panels to kilns for testing; side view of blower and air ducts.

For controlling temperatures in the refractory and spalling furnaces, both optical and radiation pyrometers are used.

(2) The Navy Spalling Test The Navy spalling test consists of subjecting the test brick, which have previously undergone the refractoriness test, to 10 cycles of alternate heating at 2650°F for 20 minutes and cooling with high velocity air (10,300 cubic feet per minute) at atmospheric temperature for a like period.

In the four hours required to heat up the spalling furnace to 2650°F each panel to be tested is subjected to the furnace temperature for two hours before the air spalling begins.

The steel frames being clamped together permit easy shifting from furnace to air ducts by means of a chain block and overhead trolley.

After the spalling test the panels are first photographed and then dismantled. The spalled portions of each brick are removed by the fingers after which the panels are reassembled, weighed, and photographed.

The loss in weight of the spalled brick over the original weight of the brick under test furnishes the basis of comparison between an approved brand and the brick under test for approval.

V. The Mellon Institute Spalling Test

The equipment used in the Navy test is quite similar to that used and developed by the Mellon Institute. The two tests differ considerably however.

The Mellon Institute Spalling Test is fully described in the *Journal.*[2] The following paragraphs from this article give briefly the main points of this test.

The test panels are preheated for 24 hours in front of a furnace operating at 1600°C. During the preheating period the brick are backed up with eight inches of calcined diatomaceous earth. After the panels have cooled they are examined and photographed.

The preheated panel is spalled by placing it in front of a furnace operating at 1450°C for 10 minutes producing a surface temperature of 1000°C and then removing it to be cooled for the same period by air-water (mist) blast. After twelve heatings and coolings (12 cycles) the panels are dismantled and all excess kaolin is removed by scraping with a trowel. The average loss in weight in percentage is reported as the spalling loss.

Provided the above treatment does not produce a spalling loss of 5% the complete test should be repeated a second and possibly a third time.

From this, a comparison of the Navy and Mellon Institute tests will show that the time and

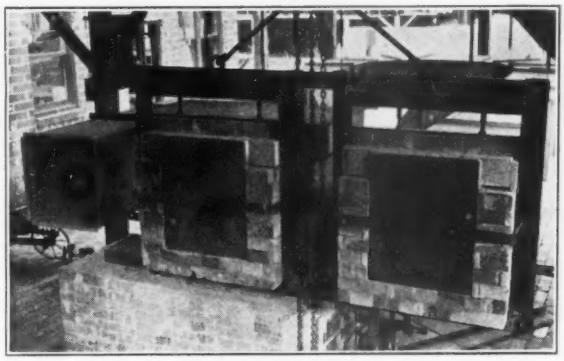

FIG. 3.—Panels clamped together for spalling test.

temperatures required are practically the same in the preheating test. The Navy test requires two 24-hour runs, one at 3000°F and one at 2900°F, while the Mellon Institute test utilizes only one 24-hour run at 1600°C (2912°F).

In the spalling test the Navy test makes use of only high-velocity air for spalling while the Mellon Institute test requires air and water in the form of mist. The number and time of cycles also differ in the two tests, the Navy specifying 10 cycles of alternate heating for 20 minutes and cooling for a like period, while the Mellon Institute test requires 12 cycles of alternate heating for 10 minutes and cooling for a like period.

No comparative test results by the two methods are available at this time.

[2] S. M. Phelps, S. M. Swain, and R. F. Ferguson, "A Service Spalling Test for Refractories," *Jour. Amer. Ceram. Soc.*, **14** [5], 389–402 (1931).

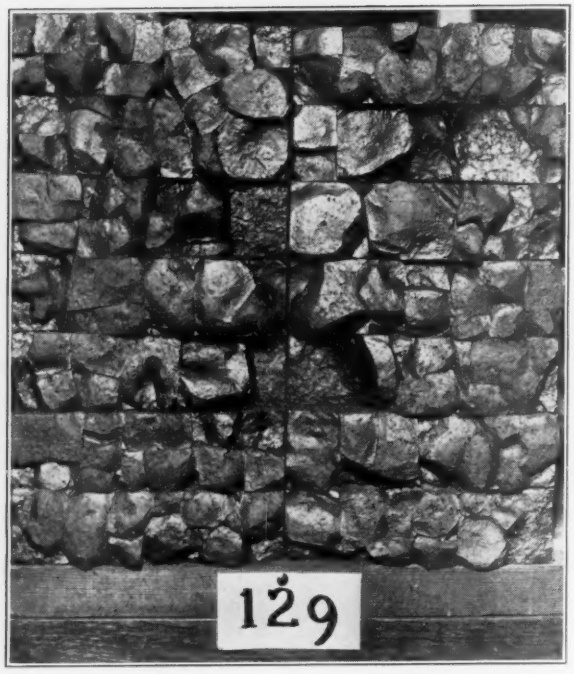

FIG. 4.—Panels of fire brick after spalling test.

VI. Details of Construction of the Navy Furnaces

High alumina brick were used in the construction of the refractory test furnace with the exception of the baffles, the combustion chamber floor, and supports, which are built of silicon carbide brick.

In the construction of the spalling furnace, No. 1 fireclay brick were used with the exception of the baffle, which is of high alumina brick.

The spalling ducts are constructed of light galvanized metal with openings 20 inches square. The straight-away sections are eight diameters long, which insures uniform distribution of air pressure over exits.

Acknowledgment We are indebted to the Officer-in-Charge of the Naval Boiler Laboratory at Philadelphia for the helpful information given us while constructing the furnaces.

GLADDING, MCBEAN & COMPANY
SEATTLE, WASHINGTON

SOME USES OF SODIUM SILICATES IN THE CERAMIC INDUSTRIES*

BY WILLIAM STERICKER

Commercial sodium silicates vary from crystals of $Na_2SiO_3 \cdot 5H_2O$ to highly colloidal solutions containing silicates as siliceous as $Na_2O:4SiO_2$. The crystalline and colloidal materials have quite different properties, and the dividing line between them comes at a ratio of approximately $Na_2O:1.6SiO_2$. The solutions vary greatly in specific gravity from about 1.3 to 1.9. The silica present buffers the Na_2O so that in solutions of a given silicate the p_H varies only slightly, but different silicates diluted to give the same total Na_2O will have quite different hydrogen-ion values.

A temperature of at least 1150°C is required to melt sand and soda ash to obtain the silicate glass of the ratio $Na_2O:3.3SiO_2$; 1350°C gives much better results. After the silicate is once made, however, it liquefies at a much lower temperature—840° for the glass mentioned. This has led to the use of powdered glass of this ratio in enamels. Since the silicate is more expensive than the ingredients it replaces, it has only been used commercially in enamels which are hard to make or in which special effects are desired. Its value has been shown with high silica, acid-proof enamels. It has chiefly been used in dry-process enamels, although one manufacturer uses it in a wet-process enamel. Manson[1] showed that frit prepared in the ordinary way contained free silica and therefore was less acid-resistant than the silica content would indicate. The enamel made with sodium silicate flowed more freely. The time required for smelting a frit containing sodium-silicate glass was less than that required when silica and soda ash were used in the batch. This is an important factor because there is a chance of losing opacity. If the opacifier is volatile, it may be lost by vaporization or sublimation. If it is nonvolatile, it may be dissolved in the glass. Theoretically, the enamel should have greater resistance to thermal shock when the silica is completely combined.

The use of sodium silicate as a glaze appears

* Presented at a meeting of the Pittsburgh Section of the American Ceramic Society, April 11, 1933. Received May 5, 1933.

[1] M. E. Manson, "Sodium Silicate, a New Enamel Raw Material," *Jour. Amer. Ceram. Soc.*, **14** [7], 490–94 (1931).

to be quite old, as a recent exhibit at the Library of Congress showed a plate from a book on the chemistry of the Assyrians[2] in which a method was given for the preparation of a sodium silicate containing Styrax gum, which was used as a blue glaze. This method was used in the reign of Ashur-bani-pal (668–628 B.C.). A more recent blue enamel using sodium-silicate glass has been developed by Edgar Littlefield.[3] It is useful at a low temperature (cone 9). The best results were obtained with

$$\left.\begin{matrix}0.8Na_2O\\0.2CaO\end{matrix}\right\}0.25Al_2O_3\{3.75SiO_2$$

5.5% copper carbonate added.

More than $0.4Al_2O_3$ affected the color, while with less alumina than the amount given, the glaze devitrified. If the lime were increased to 0.35, the glaze became green.

Baggs and Littlefield[4] used this glaze without fritting to obtain results similar to the Chun pottery of the Sung dynasty in China. Reduction to give copper red was brought about by the use of silicon carbide. Even in an oxidizing kiln atmosphere, it was found possible to control the areas of reduced and oxidized glaze.

To those who have never seen it before, the results of the addition of a few drops of a silicate solution to a stiff mixture of clay and water are almost miraculous. Upon thorough mixing, the clay slip flows freely. This fact is used in casting. Some such method must be used to cast heavy pieces. One reason silicates are particularly good for casting is that they react rapidly with calcium sulfate. The molds for casting are made from plaster of Paris and when the slip comes in contact with them, the silicate reacts with the calcium sulfate and the clay is again flocculated. This is an example of a reaction between a soluble silicate solution and a relatively insoluble material with which it is in contact. The deflocculation by silicate solutions is also used for clay purification.

Other alkalis also deflocculate clay but McDowell[5] showed further that on an equal Na_2O (chemically equivalent) basis silicate was the most effective and that the more siliceous silicates were more effective than the alkaline silicates. In practice, a mixture of silicate (usually $Na_2O{\cdot}3.3SiO_2$) and sal soda is used. Silicate alone is said to yield "stringy" slips but some manufacturers use silicate alone without this trouble. The total deflocculent usually equals 0.1% of the weight of the clay. McDowell suggested the use of 80% silicate and 20% carbonate but as high as 50% carbonate is used.

Silicates have been used in casting sanitary ware, pottery, tableware, glasspots, and brick. Kleeman[6] found that with a 30% porcelain slip, electrical casting gave a creamy layer which was unsatisfactory. When from 0.1 to 0.3% of silicate was added, the concentration of the slip could be increased to 60% with the same viscosity or fluidity. Castings made from this slip were solid when deposited.

Oxygen and silicon are the two most abundant elements on the face of the earth, making up 74.9% of the total.[7] In the early days of qualitative chemistry, much work was done on the analysis of minerals with many speculations on the chemistry of silica. The great complexity of these materials and the apparent tendency of silica to be an exception to the law of multiple proportions evidently discouraged many workers. In recent years comparatively few chemists have entered the field of silicate chemistry and most of these have studied high-temperature reactions, usually from the phase-rule viewpoint. A practically uncharted region is that of the reactions of silicates of the alkali metals which are soluble in water. These can react with soluble and insoluble compounds, even in soluble silicates, at ordinary temperatures. Of course, increased temperatures increase the reaction. Some of these are of interest to ceramic chemists; for example, when plastic cements are packed in tight containers, they must remain plastic until used. If the clays used react with the silicate at ordinary temperatures, this condition is not met and the cement is unsatisfactory. The presence of small amounts of impurities may cause setting-up in the can. Clays which do not react at room temperature may do so at higher temperatures; for example, a clay which did not react at all on

[2] R. C. Thompson, On the Chemistry of the Ancient Assyrians, p. 58, London (1925); *Ceram. Abs.*, **5** [2], 43 (1926).

[3] Edgar Littlefield, "A Copper Blue at Cone 9," *Jour. Amer. Ceram. Soc.*, **15** [5], 269–70 (1932).

[4] A. E. Baggs and Edgar Littlefield, "The Production and Control of Copper Reds in an Oxidizing Kiln Atmosphere," *ibid.*, **15** [5], 265–69 (1932).

[5] S. J. McDowell, "The Effect of Various Sodium Silicates and Other Electrolytes on Clay Slips," *ibid.*, **10** [4], 225–37 (1927).

[6] R. D. Kleeman, *Phys. Rev.*, **20**, 272–79 (1922).

[7] F. W. Clarke, "The Data of Geochemistry," *U. S. Geol. Surv. Bull.*, No. 770, p. 36 (1924).

standing for weeks rendered over 50% of the Na_2O in a solution of $Na_2O:2SiO_2$ insoluble on firing.

Reactions such as these are used in the manufacture of abrasive wheels. Silicate is mixed with clay or other reactive material and abrasive grains, tamped into molds, dried, and fired. The product should be insoluble for many purposes. Zinc oxide is sometimes added to decrease solubility.

Some forms of calcium carbonate react quite readily with sodium silicates of which $Na_2O:2SiO_2$ is the most reactive. Such mixtures have been used as adhesives and paints. In Europe roads have been built using limestone and silicate. The durability of the pavements thus formed is dependent upon this reaction.

When siliceous silicates are applied to surfaces and allowed to dry, clear, attractive coatings are formed. Many persons have thought that this was a "cold enamel." Unfortunately, however, these coatings are not permanent and in the course of time they check and crack. If pigments are mixed with certain silicate solutions, however, it is possible to form satisfactory flat paints, which have been used for decorative purposes in Germany. A very white paint has been used in this country for various purposes.

Although silicate films on the surface are not stable, dilute silicate solutions will penetrate into concrete and other formed bodies with which they react to form a resistant surface layer. Such surfaces, however, do not have a gloss.

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PROBLEMS OF HANDLING AIR IN THE CERAMIC INDUSTRY*

BY R. R. ROBINSON

I. Introduction

Problems of handling air may be classified as follows: ventilation, heating, drying, cooling, dust removal, dust collection, and combustion. These problems are common to the ceramic industry and require considerable attention from the technical force as well as a good deal of power to drive the equipment necessary for the solution of the problems.

Before discussing any of the problems mentioned it is best to consider the nature of the gas which is to be handled.

(1) Weight and Volume Air has all the characteristics of a perfect gas, that is, a definite volume of air would shrink to nothing if its heat were removed until the temperature reached the point of $-459.6°F$. For practical purposes this figure is considered as $-460°F$, and is known as the absolute zero. Thus the volume of a definite weight of air is proportionate to the absolute temperature. The pressure of air is measured by the barometer and varies at different times so that the volume of a definite weight of air is inversely proportionate to the barometric pressure, and the weight of the given volume is inversely proportionate to the absolute temperature and directly proportionate to the barometric pressure. Dry air at 70°F and barometric pressure of 29.92 inches Hg weighs 0.07495 pound per cubic foot.

(2) Specific Heat Air, like other substances, has the ability to absorb heat, and the amount of heat which a given weight of air will absorb, in proportion to the amount the same weight of water would absorb with the same amount of increase in temperature, is known as specific heat.

NOTE: A pound of water, in rising one degree of temperature, absorbs a definite amount of heat which is called a British thermal unit (abbreviated B.t.u.). The specific heat of air is 0.2415.

(3) Moisture Carrying Capacity. Air has the capacity of carrying a great deal of moisture or water-vapor. Water-vapor may occur in any space regardless of the presence of air if the liquid is close at hand. The amount of vapor the space can contain is dependent entirely upon the temperature. The amount of water-vapor in a given space is independent of the presence of air. The ratio of the amount of vapor present to that possible at the temperature is called relative humidity. The

* Presented at a joint meeting of the Pittsburgh Section, American Ceramic Society, and the Whitewares Division, Ohio Ceramic Industries Association, New Castle, Pa., May 22, 1934.

temperature at which a given weight of water-vapor will start to condense is called the dew point. W. H. Carrier gives, as controlling factors of the rate of evaporation from a free water surface, (1) vapor tension of water corresponding to its temperature, (2) vapor tension of moisture in air corresponding to its absolute moisture content or dew point temperature, and (3) effective velocity of air over the surface.

(4) Effect of Water-Vapor upon Air Density The density of the air is decreased by the absorption of water-vapor. The weight per cubic foot of air decreases as the amount of water-vapor increases. Thus, if the specific gravity of air is considered as being 1, saturated water-vapor will have a specific gravity of 0.6221, so that a dry air and water-vapor mixture in which the total amount of vapor possible at a given temperature is present would have less weight per cubic foot than pure dry air at that temperature. As an example, pure dry air at 70°F, 29.92 inches Hg barometric pressure weighs 0.07495, while saturated air at the above condition weighs 0.07425.

For calculations of air flow the weight must be reduced to some standard density. The density standard arbitrarily adopted is 0.0746, that is, the density of air at 70°F, 29.92 inches Hg barometric pressure, and 50% relative humidity.

Air density is determined by dry- and wet-bulb thermometers held together in an air stream (this stream should have a velocity of over 500 feet per minute). If there is a difference in the readings, it is known that the air flowing does not contain as much moisture as it could at the temperature recorded. The difference in the two thermometer readings represents a definite amount of moisture in the air and in turn a definite relative humidity and a definite pressure due to the vapor in the air. This pressure is a measure of the energy required to evaporate the water.

At the standard given here, the dry bulb would read 70°F, wet bulb 58.5, and the dew point or temperature at which the moisture in the air would precipitate would be 50°F, while the air would contain 54 grains of water-vapor per pound of dry air.

II. Problems of Handling Air

(1) Air in Flow All the problems of handling air are those of directing energy. Nothing can be started in motion without the application of energy, nor can anything be kept in motion in a definite course without directing the energy which causes the motion. With air under flow in confined spaces, there are two kinds of energy, potential and kinetic, and also definite laws which govern the flow. The potential energy is termed static pressure and the kinetic energy is termed velocity pressure. These are often called static and velocity head. The sum of the two or the total energy is known as total pressure or total head.

In an established or fixed duct system, with no changes in the duct occurring, there is a definite relation between the quantity or volume of air flowing and the pressure at which it flows. This relation never changes no matter what change occurs in the quantity of air unless the duct system is changed. Many names have been given to this relation but perhaps the most convenient is that known as equivalent orifice. The equivalent orifice is the orifice through which the air would flow if there were no friction, and it is determined by the formula,

$$EO = 0.0004 \times \frac{Q}{\sqrt{h}}.$$

Where EO = equivalent orifice
Q = quantity or volume
h = head or pressure
0.0004 = a coefficient which takes into account loss of area when air flows through an orifice in a thin plate

From this formula it is seen that the following laws govern the size of the orifice:

The orifice is inversely proportionate to the square root of the head. The orifice is directly proportionate to the quantity.

With a constant duct system the following laws govern:

The head varies as the square of the quantity, and the power varies as the cube of the quantity. The quantity would therefore vary as the square root of the pressure.

Having thus considered the nature of the gas which must be used with various problems of the ceramist and the laws which govern the flow of that gas, the problems which must be solved are discussed.

(2) Ventilation One of the most common problems in the ceramic industry is that of ventilating. Ventilation perhaps may cover most of the other problems listed in this paper. For discussion here, however, it will be considered as a problem of making working spaces

comfortable by introducing fresh air. In many cases, ventilation is merely a matter of removing a certain amount of air from a room or confined space and allowing fresh air to flow in. This is the exhaust system and usually consists of placing disk fans in an advantageous place where they will exhaust the air from the room. Often those fans are arranged to blow into the room.

Ventilation may be secured by making use of the difference in the weights of the outside and the inside air due to a temperature difference. This system of ventilation is called natural draft and is not efficient when most needed, namely, in very hot weather. It is often necessary, when ventilating, to use duct systems for both blowing and exhausting, bringing the fresh air to the room by means of large ducts and exhausting from the room with ducts or with the so-called wall fans. These systems have the advantage of placing the air where it is most needed and of giving opportunity for dust removal and moisture additions.

Where humidity control of air is necessary, the duct system must be used. Ducts may be proportioned in various ways, the most common being to proportion the main ducts for uniform velocities and the laterals or outlets to pass the needed volume at the pressure available at those points. For absolute control of conditions in a room, the duct system is necessary and the walls of the room must be kept tight so that the flow of air can be controlled without interference due to leakage. It is impossible in such a short space to discuss in detail the layout methods employed and the equipment used for the systems.

(3) Heating Wherever possible any heated air which is going to waste from furnaces should be utilized. However, it becomes a question of balancing the cost of power required to propel the heated air against the cost of fuel for furnishing heat.

When calculating the heat required for any building, it is necessary to take into account the amount of heat units required to heat the air space in a given period of time, the amount of loss through the various walls of the building due to the use of various materials, and the number of air changes in the building within a given period of time.

In delivering the necessary air to raise the temperature of the room, use must be made of the specific heat of air. It has been found best in practice in any kind of heating to keep the air in circulation by mechanical means.

(4) Cooling It is often necessary to accelerate the reduction of temperature in ceramic ware. This is done by increasing the flow of air over the ware, so that the air absorbs the heat. The rate of flow and the rate of heat reduction, of course, are dependent upon the nature of the ware. In any case, whether the cooling is that of ware or spaces in rooms, the use of the specific heat of air is necessary to determine the volumes which must be propelled in a given unit of time. It is also necessary to know the heat conductivity of the materials. Cooling can be done in an exacting manner if the different factors which enter into the problem are taken into consideration and employed in the calculations.

(5) Dust Removal One of the most serious problems in any industry is the floating of fine particles of dust through the air. This problem can become a serious one as is evidenced by the cloud of dust which floated over the United States on May 10, 1934, from Montana to the Atlantic Seaboard. According to a news statement this cloud of dust was one mile thick, 900 miles wide, and 1500 miles long. A published estimate stated that approximately 40 tons of dust were suspended in each cubic mile of the atmosphere and that the relative humidity was reduced from 70 to 30% with the arrival of the dust. Assuming an average temperature of 50°F, relative humidity of 30%, and 29 inches Hg barometric pressure, a cubic mile of air would contain 147,180,000,000 cubic feet or 1,839,750 cubic feet of air per pound of dust. Although the proportionate amount of dust was low, it caused a great deal of damage. In many plants the dust content is 1000 times that of the great dust cloud.

DUST CLOUD

Dust per cubic mile, 40 tons
8:00 A.M., temp. 70°, 70% relative humidity
6:00 P.M., temp. 70°, relative humidity dropped to 30%
Average temperature of air one mile high, probably 50°F, relative humidity 30%, barometric pressure 29 in. Hg, density 0.07538 lb.
1 cu. mile = 147,180,000,000 cu. ft. air
1 cu. mile = 11,095,000,000 lb. air
40 T. dust = 80,000 lb./cu. mile

$$\frac{80{,}000}{11{,}095{,}000{,}000} = 0.00000721 \text{ lb. dust per lb. air}$$

1,839,750 cu. ft. for each pound of dust (not much dust per pound air, yet this dust was annoying and harmful).

In collecting fine material, it is always best to collect it at the origin with hoods having air ducts leading to an exhaust fan. The hoods should be

so arranged that the velocity of air entering the open spaces will be high enough to keep all dust from exuding. Piping systems should be large enough to allow the air to flow at as low a velocity as will carry the dust. As a rule, one pound of material can be carried with one pound of air. However, it is best to use the ratio of $1^1/_2$ pounds of air to 1 pound of dust.

Dust is collected in three ways: (1) by the positive method or that of filtering the dust from the air, (2) by the centrifugal method or that of circulating the air at a high velocity with a rotary motion, and (3) that of decreasing the velocity of the air to such a point that the dust will precipitate.

Many types of filter collectors are in use where space is more valuable than power or where the collection of very fine materials must be complete.

The centrifugal method makes use of a conical-shaped receptacle into which the dust-laden air stream enters at a tangent of the largest diameter near the top and whirls at high velocity around the outer wall, gradually expanding so as to form a cyclonic column of air in rapid motion. The discharge, at the center of the top, is much greater in area than the entrance so that the discharge velocity is relatively small. The resulting action is cyclonic with the dust dropping in the center of the vortex. The amount of dust escaping from the centrifugal collector is dependent upon the outlet velocity.

The velocity precipitation method employs the use of a duct which is smaller in cross-sectional area at the entrance end than at the discharge, and allows the velocity of air to decrease gradually until the dust precipitates. If placed so as to discharge vertically, such a collector can be used to segregate ground clays according to texture.

PRECIPITATION VELOCITIES

Mesh	Specific gravity	Velocity (ft./min.)
300	2.5	5
300	1.75	3.8
300	1.5	3.1
200	2.5	12
200	1.75	9
200	1.5	7.5
150	2.5	26
150	1.75	18
150	1.5	16
100	2.5	48
100	1.75	34
100	1.5	30
65	2.5	100
65	1.75	70
65	1.5	60
48	2.5	175
48	1.75	155
48	1.5	110

The accompanying tabulation will show precipitation velocities (velocities at which dusts of different mesh and different specific gravities will precipitate).

As an example, 300-mesh dust will precipitate at any velocity below 3.1 feet per minute.

(6) Drying In drying, the moisture is vaporized and the greater the heat energy applied to this process, the more rapid is the drying. When the temperatures of air and ware are the same, the relative humidity of the air can be reduced gradually so that the vapor pressure in the clay will be greater than that of the air and cause the vaporized moisture to exude.

The speed with which the moisture is carried away from the space surrounding the ware depends upon the relative humidity and the velocity of the atmosphere in the drier. If the principles stated here are observed in practice, the source of heat, whether it be from steam coils in a confined chamber in which the ware is placed, from a coal fire, or in the air itself which is taken from cooling ware and often called waste heat, is immaterial.

The practical application of the principles has been one of great difficulty, however, especially with the use of waste heat. In using air which has been heated by the cooling of ware or from the radiation of furnaces, etc., great care must be taken in the early period of drying to be sure that the humidity of the heated air is high and that the air is directed to every possible surface of the ware.

The drying may be accomplished by (1) changing the condition of the air while the ware remains in the same chamber, or (2) moving the ware from one chamber to another. The latter is known as the continuous process and seems to be the most difficult to control since the air enters at a comparatively high temperature and, while imparting its heat to the ware and containers, carries away the moisture which the exchanged heat vaporizes. With the continuous process, the moisture which is taken from the ware must be sufficient to keep the humidity of the air at the temperature available within the limits determined by experiment with the specific type of materials to be dried.

(7) Combustion For most pulverized coal installations 12 pounds of air per one pound of coal are sufficient for complete combustion.

The writer has obtained the most thorough mixtures of natural gas with air by mixing gas and air in a blower and delivering the mixture through a manifold to an orifice where the combustion occurs. Approximately 10 cubic feet of air for each cubic foot of gas and, in blower mixing, 6 ounces per square inch of air pressure are the maximums needed for complete combustion. Mixtures in which the gas is from 9 to 9.5% of the total make the hottest flame.

With liquid fuel the variation in weight determines to a large extent the methods of burning.

In any of these problems of combustion, the air should be conducted through ducts of a capacity to carry the air or the mixture of gas and air at velocity pressures not exceeding 10% of the static pressure needed at the burner.

III. Methods of Moving Air

Air may be propelled by two distinctly different methods, natural draft and mechanical means. With natural draft, the velocity is dependent upon temperature differential and the height of the stack through which the air passes. The velocity may be determined in any given stack with the following formula[1a]:

$$V = 480 \sqrt{\frac{h\,(t_1 - t_0)}{460 + t_0}}$$

Where V = velocity
h = height of stack
t_1 = average stack temperature
t_0 = temperature of outside air[1b]

Air is propelled mechanically by the use of fans. There are two distinct types of fans, the disk and the centrifugal. The disk fan is one through which the general direction of air flow is parallel with the axis of rotation. In a centrifugal fan the air enters parallel with the axis of rotation and is discharged at right angles to that axis. Each type of fan has characteristics which in general are common to both but which in detail are very different. The general characteristics are as follows: (1) rim ratio, the relation of the rim or peripheral speed of the fan to the potential air speed due to pressure, (2) volumetric capacity, the ratio of the volume delivered to the product of the volumetric contents of the wheel (considered as a cylinder) multiplied by the number of revolutions per minute, and (3) specific speed, the speed in revolutions per minute the unit must run in order to produce 1 air horse power at 1 inch of water gage.

In testing fans to determine the above characteristics, the fan unit is run at a constant number of revolutions per minute, and the orifice of the duct system to which the fan is attached is changed. By changing this orifice, the stream of air flow is deformed so that when the performance is plotted it is essentially the same as the pressure deformation chart so well known to ceramic technologists. The differences in blading construction of the fan wheels, in casing construction, and in general types of fans influence the nature of the curves shown on the charts. It can be seen from these charts that any change in the orifice of the duct system to which the fan is attached will change all of the characteristics of the fan so that, while the fan may be very efficient with one duct system, the same unit placed on another with a different orifice of passage may not have a high efficiency. It is well, therefore, to be familiar with the characteristics of the type of fan to be used.

Before applying that type to any specific problem every engineer who intends to apply fan units to duct systems should be thoroughly familiar with the fact that the equivalent orifice or orifice of passage of the system is dependent entirely upon the system and not upon the fan. The fan has absolutely nothing to do with the equivalent orifice of this system.

ROBINSON VENTILATING CO.
ZELIENOPLE, PA.

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[1] (*a*) From Warren Webster & Company's "Steam Heating," p. 54.

(*b*) Babcock & Wilcox Company's "Steam" gives chimney draft thus:

$$D = 0.52h \times P\left(\frac{1}{T_0} - \frac{1}{T_1}\right)$$

D = Draft in inches W.G.
h = Height of chimney in feet
P = Pressure of atmosphere 14.7 lb. per sq. in.
T_0 = Absolute temperature surrounding air
T_1 = Absolute average temperature of stack gases

For 70 ° air, $V = 4000 \sqrt{D}$

For *T_1° air, $V = 4000 \sqrt{D} \sqrt{\frac{T_1}{530}}$

Substituting for D we get

$$V = 4000 \sqrt{\frac{0.52 \times 14.7h\,(T_1 - T_0)}{T_0 T_1}} \sqrt{\frac{T_1}{530}}$$

which reduces to $V = 480 \sqrt{\frac{h(t_1 - t_0)}{460 + t_0}}$

* Zero air—absolute temperature.

VALUES DERIVED FROM HIGH-SCHOOL CERAMICS*

By Arnold Bookheim

The scope of this paper is necessarily narrow since few high schools offer courses in ceramics today. Before going further it might be well to define ceramics.

Although at one time the name "ceramic" was thought to refer only to the art of pottery, current usage has broadened the term to include almost all silicate industries. The etymology of the term[1] shows that it has been derived from the Greek word *keramos*, which was formerly a general term designating the product of the potter's art, though now commonly meaning "a potter," "potter's clay," or "pottery." The etymology further shows that this Greek word is related to an older Sanskrit root meaning "to burn" and, as used by the Greeks themselves, its primary meaning was simply "burnt stuff." The fundamental idea contained in the word was that of a product obtained through the action of fire upon earthy material. The term "silicate chemistry," proposed as a substitute term for ceramics, is not satisfactory because it does not connote the idea of the use of heat in the formation of the product.

As now accepted,[2] two characteristic elements are involved: first, a product in the manufacture of which heat treatment is involved; and second, a product customarily manufactured entirely or chiefly from raw materials of an earthy nature, as distinguished from those of an organic and metallic nature. This definition is so broad that it covers nearly one-third of the field of industrial activity as indicated in the list of products which are now classified as ceramic. Present high-school courses deal only with structural ceramics and pottery.

There are few such courses and those that exist have been instituted to fill a definite need felt in the community in which they were established. In America, the first secondary school course in ceramics was established at the Trenton Industrial and Arts School in New Jersey in 1898 and was entirely vocational in nature. Other leading courses in ceramics are given at East Liverpool, Ohio, at McKinley High School in Sebring, Ohio, Cleveland Technical High School, Los Angeles Technical High School, and the Industrial Art School in Chicago.

The sole aim of the course in ceramics as reported by Pollock and Tait[3] is to help the pupil to be a more valuable employee, benefiting primarily the pupil and, secondarily the employer. This is accomplished by developing (1) character qualities: (*a*) honesty in performing and reporting experiments; (*b*) fidelity in obeying instructions even when unpleasant to do so; (*c*) coöperation, neither "hogging" the work for praise nor shirking it through laziness; "the group spirit"; and (*d*) initiative. (2) Good work habits: (*a*) accuracy in thought and performance; (*b*) thoroughness; complete everything started; (*c*) cleanliness and neatness; and (*d*) punctuality and regularity. (3) General ceramic information: (*a*) theoretical chemical and physical operations; (*b*) practical chemical and physical operations; and (*c*) relation of (*a*) and (*b*). (4) Interest: (*a*) fabrication of odd pieces; (*b*) field trips; and (*c*) arousing curiosity.

A typical course of study in high-school ceramics includes a large amount of shop and laboratory work and as much mathematics and science as it is possible to give in a secondary school. The East Liverpool course includes the following subjects:

First year: modeling, free-hand drawing, elementary algebra, and English.

Second year: modeling and shaping, free-hand drawing, geometry, chemistry, and English.

Third year: factory process work, elementary design, physics, trade information, principles of ceramics, and English.

Fourth year: decorative processes, ceramic design, principles of ceramics, American history, civics, and English.

Thus we see that the values claimed for ceramics are much the same as those claimed for science and mathematics. The full discussion of those values is left to the many papers on these subjects. Instances where ceramics helps develop certain values and its one outstanding point of superiority are pointed out.

* Received December 20, 1933.

[1] W. A. Oldfather, "Etymology of the Word 'Ceramic,'" *Jour. Amer. Ceram. Soc.*, **3** [7], 537 (1920).

[2] Report of the Committee on Definition of the term "Ceramics," *ibid.*, p. 526.

[3] S. H. Pollock and L. G. Tait, "Ceramics at Sebring High School," *Bull. Amer. Ceram. Soc.*, **7** [7], 214–17 (1928).

Clearness of thought and expression is developed in ceramic courses by demanding accurate work in the laboratory and accuracy in thought and performance.

Let us take a situation in the ceramic laboratory. We have a certain number of glaze materials which increase fusibility and a number which decrease it. Each one also lends some other specific property to the glaze such as surface texture, color, etc.; if, then, we have a certain glaze that does not mature at the desired temperature, which one of these materials and how much of it should be added to correct this defect? The solving of such problems helps to develop logical and accurate reasoning power. It follows that the same type of problem helps develop good judgment.

There are many types of ware in ceramics and for each type there are many different body compositions all maturing at different temperatures. Which body should be used for a certain type of ware to mature at a certain temperature, and if it is a white ware and a transparent glaze is needed, what glaze will fit that particular body and at what temperature will it be best to fire the glaze? Will it be better to produce the ware by a twice-fired or once-fired method? Which one of the several possible forming processes can best be used? Many similar problems are given the students. If solving problems such as these does not help develop good judgment, what does?

It is impossible for any one to design anything without first imagining it. This is especially true in ceramics, for not only must the ceramist visualize form and color but also composition. So we add to the values developed by ceramics, imagination, particularly constructive imagination.

Rational memory is developed if the scientific method is used in teaching the subject. This can be successfully done only part of the time in ceramics due mainly to the fact that, on the theoretical side, there are few laws and principles which have become established because of the great complexity of the reactions which take place and that this method is wholly impractical for the vocational side of ceramics.

Although there are few established principles in ceramic technology there are many theories. These theories are constantly changing as modern research brings new facts to light. An open mind is therefore essential to understand what few principles there are. The teacher of ceramics should constantly keep this fact before the students. If he does so, we may claim the development of liberal-mindedness and tolerance as a value of ceramic courses.

The outstanding value gained from high-school ceramics is the development of an esthetic appreciation. In order to design ceramic ware a thorough appreciation of geometric line and form is necessary. Ceramics goes one step further, however, than the ordinary art courses in drawing in that the design is three-dimensional. It is more than drawing; it is creating; it is creating a thing of utility as well as beauty. The fact that something tangible is produced, something the student can point to as his own creation, is an incentive to do good work and to do it earnestly.

But esthetic appreciation means more than merely an appreciation of beauty. The chemist enjoys working in and appreciates a well-equipped laboratory; the mathematician appreciates the nicety of a well-worked out proof in geometry or the development of an equation in calculus; the medical man appreciates the skill used in a well-performed operation. The landscape engineer's perception of the panorama seen from a moving train is in terms of beauty; the industrial engineer's perception is in terms of utility. The artist views a mural decoration with a keen sense of its beauty of line, color, and expression; the chemist, with an appreciation of the skill which was necessary to produce the delicate colors of the paints used. Both see the same painting but interpret the sensation differently, and it is in the interpretation that the esthetic value, derived from knowledge and past experience, is brought in.

So with the ceramist; he is able to appreciate not only beauty but also composition. There are few artists who have to make their own paints, but the ceramist must create his own glazes, and it is even more difficult to create an exact color in a glaze than in a paint because the glaze must be subjected to high temperature under which chemical and physical changes occur which are not yet thoroughly understood.

The ceramist must also know how to handle body materials as well as glazes so that he may properly shape the products he designs. Therefore the student must understand the technology as well as the art of ceramics, enabling him to appreciate both the beauty of form and color and the beauty of composition. Thus these two types

of esthetic appreciation should be developed by high-school ceramic courses.

There is still a third aspect to this value and that is an appreciation of utility. It is not hard to see how ceramics might develop this with its large amount of shop work in which useful articles are made.

In the discussion of aims, honesty in performing and reporting experiments and thoroughness in all work attempted was mentioned. The former helps to develop truthfulness in thinking and both help to develop a scholarly spirit and feeling.

Fidelity, the ability to obey instructions even when unpleasant to do so (and much of the elementary work in ceramics is unpleasant for clay is not normally considered a clean substance) helps to develop control and direction of will power.

In summing up we might say that the one value which ceramics develops better than any other high-school subject is esthetic appreciation and that value which it develops equally as well as any other high-school subject is imagination. Admittedly, ceramic courses do not give the other values as well as many other secondary school courses; it is hardly conceivable that they should, since their aim is almost entirely a practical one.

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Carl B. Harrop

Carl B. Harrop, president of Harrop Ceramic Service Co., Columbus, Ohio, died September 15 of head injuries received in a fall at his home early in August.

Mr. Harrop was born at Leavenworth, Kansas, on August 6, 1880. Having moved to Columbus with his parents he attended High School and Ohio State University there, graduating with a degree in Mining Engineering in 1902.

He served as engineer of mines, Ohio State University, in 1902; assistant chemist, Bronson Portland Cement Co., Bronson, Mich., 1902; assistant chemist, National Portland Cement Co., Durham, Ont., 1903; chief draftsman, with W. D. Richardson, brickworks engineer, Columbus, Ohio, 1904.

Between 1905 and 1910 he served as secretary of the Richardson-Lovejoy Engineering Co., Columbus, Ohio. He was estimator for the Kilbourne & Jacobs Mfg. Co. from 1907 to 1910, and then served as secretary, treasurer, and manager of the Ceramic Supply and Construction Co. in Columbus from 1910 to 1913. For the next three years he was vice-president of the Richardson-Lovejoy Engineering Co.

He became part-time instructor of ceramic engineering, Ohio State University, in 1910, and was made assistant professor in this department in 1913.

Mr. Harrop remained at Ohio State University until 1924, but since 1918 was also engaged in private consulting engineering practice, specializing in continuous tunnel kilns.

In 1914 he became a member of the American Ceramic Society, and was made an active member in 1917. Six years later he was chosen chairman of the Committee on Rules, Heavy Clay Products Division.

He served continuously as secretary-treasurer of the Fellows from their first meeting, December 27, 1930, until his death. He was also a member of the Activities Committee of the Fellows.

An international figure in the field of ceramics because of the widely used Harrop tunnel kiln, he received his professional degree in ceramic engineering from Ohio State University in 1931.

His widow, two daughters, his mother, two brothers, and one grandson survive him.

A RESOLUTION BY THE FELLOWS OF THE AMERICAN CERAMIC SOCIETY

The passing of Carl B. Harrop into the realm of eternal life leaves a vacancy in the Fellowship of the American Ceramic Society which can not be filled. His loss, as a Fellow and from the beginning as our secretary-treasurer in which capacity he showed unsurpassed activity, is startling in its magnitude.

We cherish him for his friendship, his ability as an engineer, his clearness and fidelity as a teacher, and his never failing helpfulness and kindness to all of us in all things. Loyalty and integrity were outstanding traits of his fine character. We shall miss him greatly but he will live in our memories.

We wish to express our high regard for him as a man and as a progressive worker who has done much to advance the ceramic industries to which his life was dedicated. Though he is gone, the benefits of his work will continue to accrue.

His family may take some comfort in the knowledge that his life was on such a high plane and that he was held in great esteem by his fellow workers and by all who came into intimate contact with him. Their remembrance of him will ever be an incentive to carry on the good work honestly, uprightly, and efficiently as he carried on and would have continued to do had his life been spared. But we must bow in humble submission to the Eternal Will.

We extend to his wife, his daughters, mother, and brother our deepest sympathy in their bereavement.

ELLIS LOVEJOY
A. V. BLEININGER
Committee on Resolutions

I was very sorry indeed to learn indirectly of the death of our good friend and Fellow member, Carl Harrop.

I had known him for many years and always found him a very pleasant associate and a dependable co-worker in the affairs of our American Ceramic Society.

L. E. BARRINGER, *Past Dean of Fellows*

Carl Harrop was a great worker in the American Ceramic Society. He served one term as Trustee and as secretary-treasurer of the Fellows from its inception. He was a Charter member of the Ohio Ceramic Industries Association and was for several years its treasurer and a member of the Board until a year before his death.

Carl had an abiding hobby which gave him much satisfaction. He worked in wood and metals in his leisure hours making furniture and carving rare objects of art. We have suffered a great loss in the death of Carl Harrop.

GEORGE A. BOLE, *Past Dean of Fellows*

ACTIVITIES OF THE SOCIETY

Officers of the Industrial Divisions

L. E. Barringer, Charles Harder	Art	R. C. Meeker, H. B. DuBois	Materials and Equipment	J. L. Carruthers, D. A. Moulton	Structural Clay Products
W. N. Harrison, B. J. Sweo	Enamel	H. E. White, R. E. Birch	Refractories	H. D. Callahan, H. E. Davis	Terra Cotta
James Bailey, F. C. Flint	Glass			Edward Schramm, T. A. Klinefelter	White Wares

HOW TO OBTAIN UNIFORM THERMAL TREATMENT*

A Contribution to the Discussion of Combustion in Kilns

By Ralph A. Sherman[1]

All manufacturers of ceramic ware want to produce ware of uniform quality. To accomplish this it is necessary that the ware in all parts of the kiln receive the same heat treatment. In large periodic kilns the accomplishment has been difficult and the ware in the bottom of the kiln is frequently underfired, or if it is properly fired, that in the top and near the fire boxes is overfired.

Fuel for Kilns

High-volatile, long-flame coals have long been the favorite fuel for firing kilns because it was the opinion of operators that the long flames, extending to the bottom of the kiln and, at times, out of the stack, were effective in heating the ware in the bottom of the kiln.

As a part of the investigation of the use of fuel in brick kilns conducted by the United States Bureau of Mines in 1921–23, a study was made of the process of combustion in two kilns which fired refractory ware. The results of this study were presented in a paper[2] at the 1924 Annual Meeting of the American Ceramic Society and published as a part of the bulletin[3] that reported the complete findings of the tests.

The conclusions reached from this combustion study, which consisted of actual sampling and analysis of gases from various points within the kiln throughout the firings, were as follows:

(1) Combustion of the gases from the fuel bed was complete within a short distance from the point of admission of secondary air.

(2) Combustion of the gases can be carried to the center and bottom of the kiln only by the admission of secondary air at the desired point. This may be done by means of forced draft or air ducts, according to whether the pressure at the point is above or below atmospheric, or in the rectangular type of kiln by a method of alternate firing.

(3) The attainment of a uniform temperature throughout the kiln is, in general, a matter of uniform distribution of the hot gases rather than of combustion of the gases.

Misinterpreted Conclusions

Recently, there has appeared in *The Bulletin* of the Society a paper by Lovejoy[4] and correspondence between Purdy and Milener[5] and Purdy and Hepburn[6] in which the accuracy of the conclusions reached by the Bureau of Mines is seriously questioned. Actually, it appears that Messrs. Purdy and Lovejoy have misinterpreted the discussion and conclusions of the Bureau and have thus mistakenly questioned their accuracy.

The composition of the samples of gas taken from within the kiln showed that although appreciable amounts of combustible gas, carbon monoxide, hydrogen, and methane might occur immediately above the fire box, this was burned almost immediately when secondary air was admitted to the gas stream. As the checker work presented by the ware insures rapid mixing, it appears impossible to admit the secondary air at the fire box where the combustible gas is generated; delayed combustion can be had only by delaying the admission of secondary air.

These conclusions did not deny that it is possible to obtain combustion in the bottom of a kiln, in the flues, or even out of the top of the stack, as Purdy and Lovejoy state they have done. In fact, it was shown that in the rectangular kiln studied it was possible, by firing alternate ends "open" and "closed," to have the combustible gases and air meet at the bottom of the kiln and, by careful manipulation, to improve the uniformity of the firing.

Similarly, if the combustible gas and air are not allowed to meet until they enter the flues, combustion will occur there and flames of burning gas may be emitted from the stack. However, the statement in the original report that the flames seen in the setting and at the top of the stack may consist only of incandescent particles of soot and ash still stands as correct. Visible flame from a stack, par-

* Received September, 1934.

[1] Fuel Engineer, Battelle Memorial Institute, Columbus, Ohio.

[2] Ralph A. Sherman, "Combustion in Kilns Burning Refractory Ware," *Jour. Amer. Ceram. Soc.*, **7** [3], 175–88 (1924).

[3] G. A. Bole and others, "Problems in the Firing of Refractories," *Bur. Mines Bull.*, No. 271, pp. 150–61 (1927).

[4] Ellis H. Lovejoy, "Coal Requirements of Various Ceramic Ware in Firing," *The Bulletin*, **13** [7], 176–78 (1934).

[5] *Ibid.*, **13** [6], 165–67 (1934).

[6] *Ibid.*, **13** [7], 184–86 (1934).

ticularly at night, is not conclusive evidence of incomplete combustion.

Radiation from Flames

Since the investigation was conducted by the Bureau of Mines, much has been added to our knowledge of the radiation from flames. We now know that gases containing carbon dioxide and water-vapor in the amounts present in kilns fired with coal can, when in thick enough layers, radiate an appreciable fraction, up to 20%, of the heat that would be emitted from a black body at the same temperature. Further, we know that finely divided carbon and ash will materially raise the emission of a flame.

Mr. Purdy has raised the question as to whether diffusion combustion and diffusion flames are not what are required in kilns. The question of the relative merits of luminous and nonluminous flames for heating processes and the exact meaning of diffusion combustion have recently been the subject of much discussion, and a recent paper[7] by the writer reported an experimental investigation undertaken to attempt to clarify the confusion that has arisen in regard to them.

Diffusion Flame

Briefly, a diffusion flame is one in which the air and gas are admitted in separate streams with as little turbulence as possible so that combustion can proceed only as the gases diffuse into one another at the interface. The result is that the liberation of the heat is distributed over the length of the furnace, and with gases that contain methane or higher hydrocarbons, cracking and the liberation of free carbon result. To some extent, therefore, any flame in which the gases are not premixed or in which turbulence is not induced by high velocity or by checkerwork is a diffusion flame. Diffusion combustion may and does occur when secondary air is admitted to burn the combustible gases above a fuel bed.

The inference is apparently frequently drawn that a diffusion flame and only a diffusion flame has a high emissivity, that is, a high radiating power. However, strongly luminous flames of high emissivity can be obtained even with mixing, and diffusion flames may be strongly luminous or semiluminous; they may have a high or a low radiation and emissivity. The emissivity can not be accurately judged by visual observation of the luminosity of a flame; it must be determined by measurement of the radiation.

Mixing by diffusion and the production of luminous flames can and do occur between the top of the fuel bed and the setting in coal-fired kilns. By careful design, natural or manufactured gas could be fired to produce cracking and luminous flames before the setting and the advantage of radiation from the incandescent carbon particles could be obtained with these fuels. The maintenance of this slow diffusion combustion within the setting is impossible because of the turbulence.

Conclusions

It may be repeated that the findings of the Bureau of Mines, which have not been disproved, were that the air and combustible gases from one fire box will be burned as they enter the setting; if combustion is to occur within the setting the air and combustible gases must come from separate fire boxes.

[7] Ralph A. Sherman, "Radiation from Luminous and Non-Luminous Flames," *Trans. A.S.M.E.*, **50,** 177–92 (1934).

JAMES T. ROBSON DISCUSSES CERAMIC WARE FIRING[1]

I have studied the various letters on this subject and have the following comments to make.

In *The Bulletin*, p. 167 (June, 1934), the statement is made "only by extensive use of secondary air combustion can ceramic ware be given the equal heat treatment necessary to obtain and maintain uniform quality."

Practical Difficulties

While this does afford a good means for imparting heat to the ware, unfortunately it is often impossible to carry out practically. This is true in the case of most glazed ware, especially lead glazes where blistering tends to develop.

Combustion taking place on the open set ware in bisque firing is almost impossible to control accurately enough to prevent warping. Likewise due to combustion using up the available oxygen directly at the surface of the ware, it tends to cause black coring and blue stoning of bisque as well as scumming of glazes. The flame temperature of oil is so high that the combustion on most ware must of necessity take place back in the fire box.

In your reply to Mr. Milener, *The Bulletin*, p. 166 (June, 1934), you state that glazed ware have been fired unprotected by saggers using different fuels and you attribute this to proper use of secondary air. Then you further state, "more dependence must be placed on conduction and radiation which result from combustion of gases within the kiln and around the ware." I do not believe that what you and many others term secondary air, that is, air entering into delayed combustion, applies in these cases. What I think you were doing was the same as most of us do, that is, you were diluting the products of combustion with a volume of air, so-called "secondary air," which filled your kiln with a large volume of heat uniformly distributing itself throughout the kiln. In other words, by the use of this air, the localized temperature was reduced or tempered and the B.t.u.'s were distributed uniformly. Little or no secondary combustion was taking place within the setting itself. This is the reason that pressure firing gives uniform results, but if too high pressure is used, delayed combustion takes place in the setting itself, and disastrous results will occur in the cases cited.

In other words, convection for transfer of heat in firing is often very pronounced and, together with radiation and

[1] Received September 3, 1934.

conduction, will give uniform firing results and in many cases this method must be resorted to.

Unjustified Criticism

Your letter of June 20 to Mr. McKinley states, "..... the itinerant industrial representatives of local gas companies selling to ceramic industries unnecessarily expensive premixers and gas burners which make uniform kiln firing impossible." This is rather severe unjustified criticism of the gas-burner manufacturers who realize the necessity for such types of burners to produce proper firing conditions. On the contrary, they have done a fine job in their burner construction and design.

Mr. Hepburn is certainly correct in his letter, *The Bulletin*, p. 185 (July, 1934), where he states "discussions of this kind can become most confusing unless the applications to which they apply are clearly defined."

Firing Problems

On page 152, *The Bulletin* (June, 1934), in the discussion of convection these questions are asked:

> Is this why electric heating of kilns has so miserably failed? Is this why dependence on complete combustion of solid or gaseous fuels in the fire box or at the burner and convecting the heat to the ware has failed? Is surface combustion as a heat source applicable to kilns or to furnaces where equal thermal history is required throughout a given piece of ware and from piece to piece?

These questions propose to show that electric heating of kilns is a miserable failure, that complete combustion in the fire box is a failure, and that surface combustion is doubtful. But it so happens that electric firing has proved satisfactory for low temperatures where the elements will stand up and the cost of power is not excessive. Likewise in practically all direct-fired whiteware kilns, especially glost, combustion must of necessity (unless the ware is tightly saggered or muffled) take place in the fire box.

In most periodic kilns, complete combustion does not take place in the fire box and for this reason glost saggers are usually wadded and broken saggers closed up to prevent scumming, blistering, and other defects.

Surface Combustion

The surface-combustion principle employs the well-known fact that heated surfaces accelerate the combustion of gases which come in contact with them. Due to this acceleration of the combustion, the time and space required for the transformation of energy or transfer of heat to the material are considerably decreased, resulting in high efficiency, and this principle finds very general use in both direct- and muffle-fired kilns. The ware in the direct-fired kiln is heated by radiation, convection, and conduction; while in the muffle kiln, the ware is heated chiefly by radiation and conduction, the surface-combustion principle often being used in heating the muffle plates.

We know that good results are being obtained by different methods of firing, so who is to say one principle of firing is no good and the other a universal method. It is necessary to state specifically all the conditions before making definite statements and drawing decisive conclusions.

Heating and Cooling Cycles

Whether the actual most desirable firing cycle can ever be determined exactly is quite doubtful as there are so many time-temperature variables to be determined. Of course, we know the heating and cooling cycle to be very important, and we must obtain a suitable cycle or thermal history before satisfactory results are obtained; however, is not the most vital feature to give the entire mass of a piece of ware the same heat treatment all over? This I believe to be much more important than following a positively designated firing cycle, the exact limits of which are practically impossible to determine.

Take a piece of ware unevenly heated and it will practically always show defects by test. Take a piece heated up by different firing curves and in many cases it is impossible to tell the difference by test or just which cycle is best.

Uneven Firing

From a practical standpoint, in firing most ware I say the stress should be placed on heating and cooling all parts of the piece uniformly rather than on any one definite firing cycle or curve.

In *The Bulletin*, p. 211 (August, 1934), your letter to Mr. Hartford, "Defects Resulting from *Uneven* Firing" bears the proper title for discussion.

In it you emphasize the effect of wet ware on the final fired product and the influence of water in the combustion gases on the silicate reactions. This should be a very live topic and discussed thoroughly in the forthcoming Symposium. We know water delays the oxidation of ware, it retards the heating up, may change porosity or cause cracking due to expulsion of steam, and causes "spit-out" in a semiporcelain decorating kiln.

Effect of Water Vapor

You state, "from geological studies steam plays a very positive part in reactions in molten masses. I can not get away from the belief that attempts to heat ceramic ware in muffles or by electric resistors result in uneven heat history in each piece, and from piece to piece in the kiln setting, and prevent the *benefits* accruing from the gas laden with H_2O." If there are any benefits accruing from this water, I shall be very much surprised. I know I have come across many disadvantages from it in both glost and bisque firing. It is not the gas laden with moisture that leads you to believe that its presence gives an advantage over muffle- and electric-resistor type of firing; it is because the passage of this moisture-laden gas or products of combustion through the ware is imparting heat to the ware by good old convection.

A study of the effect of water vapor from the products of combustion would bring out much valuable information.

While it is true that crazing will result from strains set up due to uneven firing of a piece of ware, I think this is more an exception than the rule and that, in the majority of cases, it is due primarily to differences of coefficient of expansion of the glaze and body which is contrary to your statement. Is it not true that some glazes will always craze regardless of the firing and that glazes under compression do not tend to craze?

Radiation of Heat

You do not understand why flame (I take it you mean a yellow flame, not blue) is the evidence of solid carbon. You were correct in teaching that hydrocarbons, especially ethylene, were luminous when burned, but their luminosity is due to the cracking down of the gas into carbon. The generally accepted theory is that the carbon particles act as carriers or forwarders of the heat. These particles of carbon are instantly heated by the hot gases of the flame to a state of incandescence, in which condition they radiate heat to the cooler surroundings exactly the same as would a solid body and will follow the Stefan-Boltzman law that radiation is proportional to the fourth power of the absolute temperature of the flame.

Helmholtz showed that radiation from the luminous flame was 20 to 120% greater than from a nonluminous flame and that the greatest radiation from gases commonly used is from ethylene which is the least saturated hydrocarbon.

Decrease in Radiation

The amount of radiation decreases with the aeration with luminous flames so that the admission of larger volumes of secondary air causes the ware to be heated more by convection and less by radiation.

Likewise with increased temperature of the mixture before combustion, less radiation takes place due, I assume, to more instantaneous combustion, preventing delayed combustion of the carbon particles.

You state in this letter that G. A. Bole demonstrated very positively at the Roseville plant that a kiln heated by gases completely combusted will be a very unevenly heated kiln. Let us qualify that statement by saying, "for the kiln tested." Maybe it could be altered in construction to prove the converse.

I think there is a great deal of food for thought in this subject and I know that under your live-wire leadership much good will come from it. J. T. ROBSON[2]

[2] Allied Engineering Co., 4150 East 56th St., Cleveland, Ohio.

ELLIS LOVEJOY MAKES SUGGESTIONS FOR CERAMIC WARE FIRING SYMPOSIUM[1]

The circular letter anent a Symposium on Firing gives me undue prominence and for that reason if none other I should answer it.

Definite Subject

Symposiums are too often just rambling talks. Usually the topic is so general that it invites rambling. I would like to see the forthcoming Symposium limited to a single definite subject, namely, "Uniform Heat Distribution in the Kiln Room," with a Chairman who will ruthlessly rule out anything irrelevant.

If each participant in the discussion should prepare himself for the discussion, keeping in mind that the theme is the principles which govern heat distribution, we shall avoid endless discussion of types of kilns and kiln design except as pertinent. If each will review his thermal history and select for presentation in as brief form as possible the basic principle of his firing practice or theory applicable to the problem under discussion the result will be very much worth while.

Limited Discussion

The principles are the same whatever the type of kiln, even the common scoved kiln as I have often experienced in my factory practice and engineering work. In view of this I would limit the discussion to the car tunnel kiln and the round downdraft kiln, open-fired. Perhaps we should include the updraft pottery kiln. The compartment continuous kiln and the Hoffman type of tunnel kiln are on their way out and discussion of heat distribution in them may well be eliminated. The rectangular downdraft kiln has not kept pace with the round kiln despite its merits. Besides, the problem in it is identically that in the round kiln except in kiln floor design. We may, without loss, eliminate it. Muffled kilns are beside the question.

Pressure (Draft) Conservation

If I attend the Meeting and take part in the discussion, my theme will be conservation of available (draft) pressure for use in the kiln room as a prime factor toward uniform heat distribution. It begins with the furnaces where a lot of the limited available atmospheric pressure may be wasted or conserved; the problem concerns the ware setting; the kiln (round downdraft) floor and under-floor flues are important factors; ground insulation is vital; damper (draft) pressure control is essential.

This serves to illustrate the third paragraph above. It would greatly help in carrying out the program if each would send his theme title to the Chairman in advance of the Meeting.

Undoubtedly there will be a discussion of combustion and combustion gases. This topic is already on tap in the literature.

Suggested Topics

My suggestions of topics are as follows:

(1) Draft pressure in its relation to uniform heat distribution in the kiln room. Its conservation for the kiln room through furnace design, firing methods, secondary air, ware setting, kiln-floor design, under-floor flues, and damper control for open-fired round downdraft kilns.

(2) Combustion and heat conveyance problems, character of the kiln gases, heat transfer by convection (we shall have a hot time in the furnaces if convection rules in conjunction with slow draft for pressure conservation), by radiation from combustible gas luminous flame, by

[1] Letter to G. H. Brown, Chairman, Materials and Equipment Division. Received September, 1934.

radiation from incandescent carbon and fly-ash, and by water gas.

(3) Insulation, especially ground insulation, for downdraft kilns.

(4) Ware setting. I should like to comment on this but space forbids.

(5) High kiln domes *vs.* low domes leading to flat crowns. Flat crowns can be built on rectangular kilns, but these we have eliminated. The question may arise in the car tunnel kiln discussion.

(6) Firing practice, irrespective of the influence on draft pressure which belongs in (1), to get a maximum degree of heat uniformity throughout the kiln room. Shall we fire heavily and infrequently, developing temperature waves slightly overheating the top ware, and then work this excess heat down, or will a continuous fire best serve the purpose?

(7) Horizontal *vs.* downdraft *vs.* updraft. The first two will come up in the car tunnel kiln discussion. They would be considered in the compartment continuous kiln and the Hoffman tunnel if these were included. The updraft pottery kiln, if included, will be compared with downdraft kilns.

I am only interested in your arranging a definite program and one not too broad. One or two things thoroughly discussed are far better than a hit-or-miss discussion of many things.

ELLIS LOVEJOY[2]

[2] 480 West Sixth Ave., Columbus, Ohio.

W. D. RICHARDSON DISCUSSES MEANS OF FIRING CERAMIC WARE[1]

In the circular letter of G. H. Brown, Chairman, Program Committee, Materials and Equipment Division, is the announcement that *The Bulletin* for August concludes the series of editorials on the firing of ceramic ware. Following this is the sentence, "we hope the Society members will develop this subject further in *The Bulletin*."

Comments on Bulletin Statements

I am sure that the discussion by the Editor and others of this important operation in clay products manufacture has been appreciated and will help to direct, define, clarify, and crystallize the expressions of those who will take part in the Symposium at Buffalo. I had not thought of preparing anything on the subject for publication, but with the solicitation of Chairman Brown I am moved to send a few comments on the statements in *The Bulletin* in order to give expression to some things that I think I learned in my many years of practical experience in firing face brick with fuels in the order named: wood, natural gas, oil, coal, and producer gas, and in updraft, open-top, downdraft, round, rectangular, and continuous compartment kilns, as well as in years of engineering service in the firing of various products in many types of kilns, including the tunnel kiln. What I have learned is now well known to many who have passed through a similar experience.

The discussions of Purdy and Lovejoy bring out some interesting points upon which others should express their opinons, based on their own operations. Purdy says that "diffused combustion," defined as "delaying of complete combustion until the gases reach the ware," is necessary to secure a uniform distribution of heat, or uniform "thermal history." He also states that he has been "considerably interested in knowing why well-informed ceramists consider that a flame in a kiln necessarily has a reducing effect on the ware."

Uneven Firing

We all learned in our first experience with natural-gas firing that a closed furnace, the air for combustion being regulated entirely by valves in the mixer of the burner, gave excessively hot furnaces and combustion bags and overfired the upper part of the downdraft kiln and underfired the lower part. We soon found that we must admit air around or under the burner to give a pressure on the furnace, in order to force the heat into the whole kiln.

Lovejoy, as well as myself, was firing face brick made from impure clays containing some pyrite, that were very sensitive to reduction at high temperatures, causing iron specks on the brick that greatly reduced their sale value. It is true that not much damage was done by reduction with natural gas, since the burning of natural gas can be so easily regulated. Moreover, the fuel in natural gas is almost entirely hydrocarbons, methane (CH_4) and ethane (C_2H_6), and it is supposed that these compounds are quickly broken up in the furnace, that the H is combusted first and then the CO. Whether this is so I do not know, but I do know that air and gas can be so intimately mixed that complete combustion will take place in the furnaces and bags, with no danger of reduction of the ware. In any case, hydrogen is not a strongly reducing agent and the fact that in burning natural gas no reduction results, even with a flame among the ware, would indicate that the hydrocarbons are not to any great extent converted into CO. I see no harm in premixing with the gas enough air for complete combustion, if a flame among the ware is not desired, but excess air, preferably under greater pressure than could be had with air openings in the furnace front, is required to carry the heat from the furnaces and combustion chambers to all parts of the kiln.

On the other hand, the available fuel in coal gas, producer gas, is almost entirely carbon monoxide, which is a strongly reducing agent when it comes in contact with clayware at high temperatures, and is the fuel *par excellence* for producing many beautiful colorations on red-firing clays and iron specks and blotches on pyritic, coal-formation clays. Now the point I want to make is that flame among the ware, from the burning of carbon monoxide, especially at points remote from the furnace, *is* evidence of reducing action on ware back of the flame, among which the CO has passed. If this does not conform to Purdy's practice, it means to me that his experience has been largely with clays that are not sensitive to reducing gases.

[1] Received September 1, 1934.

Futile Researches

Purdy states that G. A. Bole "demonstrated very positively at the Roseville plant that a kiln heated by gases completely combusted will be a very unevenly heated kiln." To my mind the experiments at Roseville proved nothing, except the futility of those researches, as far as any advancement of knowledge of kiln firing is concerned. This is not a criticism of Dr. Bole, as this research was undoubtedly instigated by the associations of manufacturers and the maker of the automatic stoker and largely financed by them. Coal entirely combusted in a furnace apart from the kiln and the gases conducted to the kiln in a single flue could not be expected to heat the kiln evenly, even if the other conditions had been the best. But had there been a good gas producer in the place of the stokers and burners with regulation of gas and air, under pressure, in numerous furnaces in the kiln walls and with properly designed kiln bottoms, Bole would have demonstrated something quite contrary to Purdy's statement. Moreover, the gas from such a producer could have been served effectively to every kiln on the yard at Roseville.

Even Heat

Lovejoy and many others of us know that even in a downdraft periodic kiln with proper furnaces properly managed and a proper flue system, with outlets to each properly distributed, and proper regulation of the damper in the main flue to stack, a fairly even heat may be obtained with gases completely combusted before reaching the ware, and we could do better today, with our increased knowledge, than in our active years. With the smaller body of ware in a tunnel kiln more uniform results are possible with completely combusted gases, though it must be admitted that such results are not thus obtained in the tunnel kiln as usually constructed. But I had better stop here, or I will get to talking of my downdraft tunnel kiln with movable compartments.

Further Remarks[2]

The above statements may be misinterpreted by some, and perhaps by the Editor and Dr. Bole. This does not mean that I would change any of the statements I have made, but that I should go further and expand my views. I think, however, that you must know that I am not questioning the well-known advantages of diffused combustion, the burning of part of the fuel among the ware, as I followed this practice for many years.

What I want to bring out is that in this manner of firing, with a flame among the ware, there is a reducing action on the ware back of the flame. Yet, since reduction is often desired, especially in the firing of building brick made from red-firing clays and of pyritic coal-formation clays, which was not the case in the early experience of Mr. Lovejoy and myself, the manufacturer today has the advantage of securing more uniform thermal treatment throughout the kiln, especially in kilns with high setting, both downdraft and updraft, as well as in the tunnel kilns as generally constructed.

I might also amplify my criticism of Dr. Bole's conclusion from his researches with the automatic stoker at Roseville, and state that I do not question the fact that a more evenly heated kiln of the type there could be secured by burning a part of the fuel among the ware, especially in the lower part of the kiln, but if entirely bright red brick were desired this could not be accomplished in that way. In any case, whether the oxidized or reduced colors are desired, much better results could have been obtained with producer gas.

Postscript[3]

The Editor will understand that I have developed only one side of the question, the other side having been ably treated in *The Bulletin*. At one of our plants at Shawnee we fired in the continuous compartment kiln, with producer gas, clear buff and manganese-gray brick. Almost all were hard enough for exterior facing. By carefully keeping the flame out of the setting there was no discoloration of any kind on the brick, even on those nearest the fire, though the clay is very sensitive to reduction, and a reducing fire on brick with manganese destroys the desirable gray color. At the other plant, using the same clay fired with coal in periodic kilns, the product was a flashed iron-spot brick. Of course, the difference came from the burning of a large part of the fuel among the setting; in fact, to secure iron-spot brick to the bottom of the kiln some of the fuel will burn in the bottom flues, in the stack, and at the top of the stack.

W. D. RICHARDSON[4]

[2] Received September 18, 1934.

[3] Received September 25, 1934.

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IOWA CERAMISTS SEE VALUE OF UNIFORM THERMAL TREATMENT

Iowa State College Asked to Investigate Effect of Thermal History on Iowa Clay in Firing

At the meeting of the Iowa Clay Products Manufacturers at Des Moines, September 6, H. R. Straight's resolution to request the authorities of Iowa State College "to create a project of investigation relative to the influence of the thermal history of various treatments of Iowa clay in Firing" was adopted.

The freight-rate case, noncompliance with the Structural Clay Products Code, and the Association's activities at the Iowa State Fair were among the topics discussed by the following members present: M. T. Straight, Adel Clay Products Co., H. L. Tramp, Centerville Clay Products Co., W. J. Goodwin, Goodwin Tile and Brick Co., O. J. Whittemore and S. J. Galvin, Sheffield Tile and Brick Co., Garland Johnston, Johnston Clay Products Co., George Schnurr and Gilbert Schnurr, Kalo Brick and Tile Co., Tom Rettig, Oskaloosa Clay Products Co., R. O. Youngerman and M. D. Judd, Mason City Brick & Tile Co., H. S. Vincent, Vincent Clay Products Co., R. W. Tuller, United Brick & Tile Co., A. S. Patterson, William Queal, and Robert Goodwin, Redfield Brick & Tile Co., and A. S. Platt, Iowa-Northwest Joint Region.

AMERICAN CERAMIC SOCIETY DEFENDS CERAMIC ENGINEERING[1]

Do "Ceramic Engineering" Curricula Deserve Recognition as Engineering?

Because the Committee on Education of this Society and I, personally in editorials, have made recommendations that more time be devoted in the ceramic engineering curricula to elementary subjects such as mathematics, chemistry, physics, and geology, A. F. Greaves-Walker, Director of the Department of Ceramic Engineering, North Carolina State College, has sent me a copy of your letter to Dean Riddick and also an outline of their ceramic engineering curriculum.

Analysis of Curriculum

Dean Riddick and Professor Greaves-Walker are curious to know whether their reduction of special ceramic courses and the substitution of elementary science courses in their place is correct, in view of your letter.

There is no disposition on their part or on my part to argue this case with you, but for our own information we hope you will consent to answer the questions which will follow. We want your point of view that we may more intelligently shape ours.

I have analyzed the North Carolina ceramic engineering curriculum in the following table:

	Total Hours	%
Mathematics	34	14.44
Chemistry	25	10.54
Physics	13	5.48
Geology	18	7.59
Cultural	54	22.78
Engineering	37	15.61
Ceramics	44	18.56
Electives	12*	5.00
Total	237	100.00

* Nine hours should be added to make the total of 246 credit hours required for graduation.

In the classification of engineering subjects I have included only engineering drawing, mechanics, thermal dynamics, mechanical laboratory, materials laboratory, elements of electrical engineering, and strength of materials. This I have done in compliance with what apparently is your classification.

In the foregoing table, possible electives are not included in the engineering classification, nor are the fundamental sciences (mathematics, physics, chemistry, and geology) and the ceramic courses.

Importance of Fundamentals

We think of ceramic engineering as being of the same sort as metallurgical engineering. In ceramics we deal with the arts, science, and technology of producing useful articles from silicate minerals. Such articles have to be so compounded and so fabricated as to possess quite definite and specified properties. These properties are being more and more closely specified in such national societies as our own, the American Society for Testing Materials, the International Standards Association, the Foundrymen's Association, the American Society of Mechanical Engineers, and other technical trade associations. Specifications and standards are also being dictated by industrial needs and by the competition of nonceramic products.

The production of ceramic ware is rapidly increasing in exactness, involving the selection of raw materials, their proportioning, mixing, and the fabrication of the mixture into ware. It is becoming increasingly important that the ceramic engineer shall be well grounded in the fundamentals of mathematics, chemistry, physics, and geology. We presume that this is true in all engineering professions that deal with the fabrication of products from raw materials. Our leading industrial electrical engineers are urging an increasing emphasis of these subjects at the expense of collegiate courses in electrical engineering.

Having this vision as above sketchily given, we naturally wish to inquire of you why the subjects of mathematics, chemistry, physics, and geology are not considered an absolute essential fundamental for comprehension and performance ability in ceramic engineering.

We wonder also why you do not consider ceramic engineering as engineering.

According to our belief, these fundamental sciences and the ceramic engineering courses should be considered as engineering subjects. According to our ideas, the ceramic engineering curriculum as submitted to you by North Carolina State College has 72.22% hours devoted to the fundamentals and applications of engineering. In addition to this the student has opportunity to elect 5% more of what we class as engineering, making a total of 77.22%.

Devoting 74 hours, or 22.78%, of the ceramic engineering curriculum to cultural subjects seems to me to be a very strong recognition of the need for broadening the students' viewpoint and an understanding of their relations as citizens.

Reduction of Ceramic Courses

If I were designing a course in ceramic engineering based upon my twelve years' experience as a college instructor and my observations while industrially employed and for the past fourteen years as Secretary of this Society, I believe I would reduce the strictly ceramic courses still further in the interest of the fundamental sciences and of languages, and would urge the students to take their electives in the fundamental sciences and languages rather than in strictly engineering courses, with the belief that these are increasing in their importance in the equipment which the engineer must have. It is my personal belief that a ceramic engineer will be versatile in his ability to serve as a ceramic engineer in proportion to his knowledge and ability to use the fundamental sciences. At the same time I believe that if a person is to serve most successfully as an engineer, he must pursue a curriculum having a distinctive vocational objective, and for this reason, in my opinion, it is essential that the curriculum shall contain

[1] Letter from the Editor to H. H. Horner, Asst. Commissioner, State Department of Education, University of the State of New York, Albany, N. Y.

courses that are distinctly devoted to ceramics if it is intended to train a man in ceramic engineering.

We are differing among ourselves as to how large a proportion of the curriculum should be devoted to strictly ceramic subjects.

You would favor us greatly if you would let us have your ideas on (1) classification of ceramics as engineering, the same as metallurgy; (2) inclusion of the fundamental sciences as engineering essentials, therefore justification for adding these to make the total hours devoted to engineering in a given curriculum; and (3) the relative importance of skill in drawing and materials testing (which constitute 37 hours in the North Carolina State College curriculum) with skill and ability to compound, fabricate, and test ceramic products according to standards and specifications, which ability rests most largely upon an understanding of the fundamental sciences.

Assistant Commissioner Harlan H. Horner Replies to Editor[2]

I am glad to have your courteous letter of September 6 with reference to this Department's present inability to register ceramic engineering as an engineering course at North Carolina State College of Agriculture and Engineering. In our effort to establish a new list of approved engineering courses we have been a good deal at a loss to know just what to do about certain courses in ceramic engineering as well as certain other courses in so-called architectural engineering.

Engineering Statute

I think you will understand our position better if I tell you that our purpose in establishing the list of approved courses in engineering is to meet the provision of our engineering statute touching the licensing of professional engineers. Section 1452 of the Education Law provides in part that "every person applying subsequent to January 1, 1937, for a license as professional engineer shall be required to pass the examination and before admission thereto shall submit evidence that he has been graduated from a college or school of engineering registered by the Department as maintaining satisfactory standards."

We are registering courses in engineering to get ready to meet this provision of the statute and our examinations, which may be modified in the future, have not included ceramics at all. Indeed, work in ceramics has not been literally included in the engineering field according to our practice and procedure. We do not mean now to pass judgment upon the various courses in so-called ceramic engineering from the ceramic standpoint. We merely point out that at the moment they do not seem to satisfy the requirements for admission to our licensing examination which is set up for engineers in electrical, mechanical, and civil engineering. I fear that if we were now to register the course at North Carolina, a graduate from it would find himself in trouble in our licensing examination. As a matter of fact, does a person trained in ceramic engineering really expect to practice professional engineering as that practice is defined in our statute? I enclose a copy of our Handbook No. 36 for your information, on page 32 of which you will find a definition of the practice of professional engineering.

Definitions[3]

(4) "Professional engineer" means a person who engages in the practice of professional engineering as hereinafter defined.

(6) A person practices professional engineering, within the meaning and intent of this article, who holds himself out as able to perform, or who does perform any professional service, such as consultation, investigation, evaluation, planning, design, or responsible supervision of construction or operation, in connection with any public or private utilities, structures, buildings, machines, equipment, processes, works, or projects, wherein the safeguarding of life, health, or property is concerned or involved, when such professional service requires the application of engineering principles and data.

I do not mean this letter to be conclusive answer to your inquiry at all. I merely wish to invite further consideration of this whole question by you and your Society. Please let me hear from you again.

[2] Received September 22, 1934.

[3] University of the State of New York Handbook 36, p. 32, definitions 4 and 6.

SEPTEMBER ROSTER CHANGES

Personal

Agarwal, S. N., Rawatpara, Agra, India. (Berlin-Halensee, Germany.)

Lukens, Glen, 1041 West 31st St., Los Angeles, Calif. (Fullerton, Calif.)

Openhym, G. J., Hartsdale, N. Y. (White Plains, N. Y.)

Palmer, Lawrence A., National Lime Association, 927 15th St., N. W., Washington, D. C. (3001 Porter St.)

Pask, Joseph A., 4039 12th Ave., N. E., Seattle, Wash. (Champaign, Ill.)

Rogers, Thomas S., Sears, Roebuck & Co., Dept. 817, Chicago, Ill. (National Silica Co.)

Smith, Paul L., 816 E. Beaver St., State College, Pa. (Bloomington, Ill.)

Stone, Robert L., Ceramic Engineering Dept., North Carolina State College, College Station, Raleigh, N. C. (Newell, W. Va.)

Strong, Kenneth B., 113 S. State St., Owosso, Mich. (Chicago, Ill.)

Wills, George A., Dept. of Ceramics, Rutgers University, New Brunswick, N. J. (N. C. State College, Raleigh, N. C.)

HOTEL STATLER

Buffalo, N. Y.

will be

Headquarters for 37th Annual Meeting

AMERICAN CERAMIC SOCIETY

and

National Brick Manufacturers Research Foundation

February 17-22 inc., 1935

Eight simultaneous Division meetings
each in adjacent comfortable soundproof rooms

1100 Rooms—1100 Baths

Following rooms guaranteed available
for this Meeting

Singles			*Twins*			*Parlors*		
50	at	$3.00	10	at	$ 6.00	4	at	$ 5.50
10	"	$3.50	3	"	$ 6.50	3	"	$ 8.00
118	"	$4.00	6	"	$ 7.00	2	"	$ 9.00
120	"	$4.50	12	"	$ 8.00	20	"	$10.00
90	"	$5.00	24	"	$ 9.00	10	"	$15.00
3	"	$5.50	40	"	$10.00			
55	"	$6.00	8	"	$12.00			
12	"	$7.00						
458			103			39		

Note—Single rooms can accommodate two persons (1 large double bed); the rate for two persons is the single rate quoted plus $2.00.

WATCH THEM GET ON BOARD

Year	Paid Members			New Members		
	Personal	Corporation	Total	Personal	Corporation	Total
1933 Whole Year	1184	148	1332	55	2	57
1934 to Aug. 1	1166	159	1325	117	9	126
1934 to Aug. 28	1178	163	1341	122	11	133
1934 to Oct. 1	1202	166	1368	128	14	142

	Aug. 1	Aug. 28	Oct. 1
1934 Paid Members	1325	1341	1368
1934 Subscribers	419	426	435
Average Current Sales	100	100	100
Deferred Payment Members	58	49	49
TOTAL CIRCULATION	1902	1916	1952

Fellow Members:

Please send to me at Newport, Ky. at your earliest convenience, your list of prospective members and advertisers, as it is our desire to send to all prospective members and advertisers sample copies of *The Bulletin*, together with an appeal to join and advertise. This, we hope, will be an assistance to you in your personal solicitation.

R. B. CAROTHERS, *Chairman*,
MEMBERSHIP & ADVERTISING COMMITTEE

NEW MEMBERS

PERSONAL

Bartlett, Willard J., 1133 E. 152nd St., Cleveland, Ohio; Manager, General Electric Co., Glass Technology Laboratory.

Brewster, H. M., 2730 High St., Chicago, Ill.; Research Dept., E. R. S. Brewster Co.

Carbeau, Charles W., Ellwood Co., Ellwood City, Pa.; President.

Dettmer, Friedrich, Bad Klosterlausnitz 1 Th., Waldstrasse 13, Germany; Consulting Engineer.

Kielland, Val B., Apartado 106, Cartagena, Colombia, S. A.

Mattyasovszky-Zsolnay, Lâszló, Zsolnay Works, Pécs, Hungary; Chemical Engineer.

Shremp, Raymond M., 302 E. New Castle St., Zelienople, Pa.

Wong, On Yuen, Y. S. Fond Co., 115 Kiangse Rd., Shanghai, China.

STUDENT

Herold, John F., 165 E. Dunedin Rd., Columbus, Ohio.

CORPORATION

Findlay Clay Products Co., Washington, Pa.

Kentucky Clay Mining Co., W. J. Watkins (voter), Mayfield, Ky.

Lava Crucible Co. of Pittsburgh, Furman South, Jr. (voter), 627 Wabash Bldg., Pittsburgh, Pa.

National Lime and Stone Co., L. G. Love (voter), First National Bldg., Findlay, Ohio.

Membership Workers' Record

PERSONAL		CORPORATION	
Wm. M. Clark	1	R. B. Carothers	1
Walter Steger	2	F. C. Flint	2
F. G. Gibson	1	Harold E. White	1
Harold E. White	1		—
Hewitt Wilson	1	Total	4
Office	2		—
	—	Grand Total	13
Total	8		
STUDENT			
Office	1		

GLASS MEETING ROSTER REVEALS MEMBERSHIP PROSPECTS

The roster of the Glass Division summer meeting is printed on page 287. On hundred nine individuals are listed there. They represent thirty-seven corporations. Most of the individuals and corporations are intimately connected with the glass industry.

Fifteen of these corporations do not support the American Ceramic Society with corporation memberships. Thirty-seven of the individuals listed are not members of the Society.

Each person who attended the technical sessions of this summer meeting showed interest in the work of The American Ceramic Society's Glass Division. The work of the Glass Division must be of value to them; otherwise they would not have come to this meeting. This one fact proves The American Ceramic Society worthy of their individual membership support.

The fifteen nonmember corporations respect the work of the Glass Division. They show this respect by sending or permitting their men to attend this summer meeting. The Society deserves their Corporation Membership support.

Glass Division men know the worth of The American Ceramic Society. They appreciate its service to the nation's glassworkers. They acknowledge its value to all ceramists.

These nonmembers have also shown interest in the Society's work. Where there is interest there is potential support. Now is the time to get it for The American Ceramic Society.

REASONS GIVEN FOR MEMBERSHIP AND ADVERTISING PUSH

Thanks very much for your frank letter. It is being passed on to members of the Board of Trustees for their information.

The Society today has only half as many Personal and half as many Corporation members as it had in 1925. In 1925 and the years immediately preceding and following,

the Society enjoyed an average of more than thirty pages of paid advertising, but during the depression the paid advertising dropped to about ten pages average per month. During the depression the Society has kept in full swing on its reserves. It can do this for another year, but can not at the same time meet fully the service demands which are being put upon it to an increasing extent.

Effective Efforts

The issuance of *The Bulletin* under its own cover was an effort to regain the membership and advertising support, both of which were rapidly dwindling. You know the strenuous effort put forth by the Membership Committee last year. It was very effective and well done. The Committee has this year not gotten started, the Chairman having been appointed only about three weeks ago, but notwithstanding the inactivity of the Membership Committee we have this year secured more new Personal and Corporation members than we obtained all last year. Our Personal Membership support is within six of what it was last year, and the Corporation membership support exceeds last year by ten corporations. Without any effort other than from this office, the advertising has crept from ten to fourteen pages of paid advertising.

The facts of the case are that had not *The Bulletin* been put out under its own cover the Society would have continued to experience its loss in Personal and Corporation membership support and in advertising. With *The Bulletin* under its own cover, as a working tool, the tide has been stemmed.

Cost of Bulletin

Except for the cost of envelopes and postage, *The Bulletin* under its own cover has not cost any more than it did previously when under the same cover with the *Journal* and *Ceramic Abstracts*. *The Bulletin* has more than paid its own way.

Whereas our monthly financial statement for August shows that we have exceeded the budget allowance for publications by about $400.00, the facts are as follows:

(1) Total expenditures are within budget limits.

(2) Printers' charges for reprints have been included in the cost of publications. If this had not been done our publication costs would have been within budget limits.

(3) The cost of envelopes and postage for the publications due to the new format were not counted upon when the budget was made.

(4) With *The Bulletin* as our working tool, and with an enthusiastic Membership and Advertising Committee organized, it is fully expected that the Society will now recover its membership and advertising support so that before our reserves are completely exhausted we can begin to rebuild them.

Higher Dues

I hope with you that the membership and advertising support obtained during the remainder of this year and for 1935 will be such as to warrant the Board to rescind its action raising the Personal dues to $12.50. The facts are, however, that the survey of other societies shows that though they have this year raised dues, they have no loss in membership support.

While we appreciate your frank expression of opinion, and whereas the Board will give serious consideration to the several points you have made, the fact remains that you are one of those on whom the Society depends to secure more members and more advertising. It is only in this manner that we can obviate raising the Personal dues from $10.00 to $12.50.[1]

[1] Letter from General Secretary to a member, Sept. 8, 1934.

BUFFALO EXECUTIVE COMMITTEE FOR 1935 MEETING OF THE AMERICAN CERAMIC SOCIETY IS WORKING FAST

Tentative plans for important features of the 1935 Annual Meeting of The American Ceramic Society are announced by George J. Easter, Secretary of the Executive Committee. These plans are the result of a committee meeting, September 22, at the Hotel Statler, Buffalo, where the Meeting of the Society will be held February 17 to 24, 1935.

S. F. Walton presided at the meeting attended by the following committee members:

M. E. Holmes, R. C. Benner, H. L. Robson, D. E. Sharp, J. P. Mulroy, Murray Scott, O. I. Chormann, S. F. Walton, F. A. Lobee, Jr., E. L. Lasier, John Daniels, L. D. Walrath, W. T. Buckley, G. R. King, F. M. Thorman, W. J. Degenhart, L. D. Walrath, Jr., and G. J. Easter.

Trips for Visitors

A trip to Niagara Falls has been tentatively arranged for Thursday afternoon and evening, February 21. The visiting ladies will be entertained at Niagara Falls during the day and will join the main party for dinner and to view the colored lights on the Falls in the evening. Trips will also be arranged for the men who prefer to spend the afternoon sightseeing rather than visiting plants at Niagara Falls.

An all-day trip to Rochester is planned for Friday, February 22. Murray Scott has reported that the Bausch & Lomb Optical Co. will be glad to open its plant, and Eastman Kodak Co. is also willing to let members go through its plant if it is operating that day.

An optional all-day trip to Corning is offered for Friday. It has been decided to go only to Corning, not including Wellsboro as previously suggested.

Trips around Buffalo

Trips in the immediate vicinity of Buffalo are set for Friday afternoon, but no trips will be held on Saturday.

Plant trips will not necessarily be limited to ceramic plants but may include other places of particular interest to visitors such as the automobile assembly plants, the airplane plants, the Larkin Co., and the International Nickel Co.

Plants which can be visited in the various localities will be listed at the next meeting of the Plant Trips Committee.

Additional members have been appointed to this committee as follows: For Buffalo: F. A. Lobee, Jr., and J. P. Mulroy; for Rochester: M. R. Scott and O. I. Chormann; for Niagara Falls: E. L. Lasier and H. L. Robson. These men will serve with R. C. Benner and G. J. Easter.

Ceramic Exhibition

M. E. Holmes has reported that thus far fourteen companies have expressed interest in exhibiting at the Annual Meeting. A special endeavor is being made to have New York State firms display their ware but space at the Exhibition will also be available to national exhibitors.

The charges for space will be nominal and will cover the cost of rear-drapes and rails by the Hale Co., Buffalo.

Many animated exhibits are desired, but no strict limitation will be put on exhibitors as to the class of exhibit. Each exhibit is to be as educational as possible.

G. R. King, J. P. Mulroy, W. T. Buckley, and F. M. Thorman have been assigned to assist Dean Holmes.

Monday Night's "Shuffle"

Necessary equipment for the "Shuffle," the entertainment planned for Monday night, February 17, will cost $300. General plans for this entertainment which the committee promises will be unique, have been approved and the Entertainment Committee is now working on the details.

The nature of this entertainment is to be kept a secret.

About $400 have already been pledged by various companies, according to the Finance Committee, which is intent on securing further support of companies in the vicinity.

Plans for entertaining the ladies are also progressing and a report is expected from Mr. Hazlewood at the next meeting, scheduled for October 27.

WHITE WARES DIVISION SELECTS NOMINEES FOR 1935–36

Robert Twells and G. A. Loomis, Nominating Committee for the White Wares Division, have named the following members for the offices of the Division and for Trustee of the Society: For *Trustee:* E. H. Fritz, Westinghouse Electric & Mfg. Co., Derry, Pa., and P. D. Helser, General Ceramics Co., New York, N. Y.; for *Chairman:* T. A. Klinefelter, Bureau of Standards, Washington, D. C., and G. W. Lapp, Lapp Insulator Co., Leroy, N. Y.; for *Secretary:* S. J. McDowell, A C Spark Plug Co., Flint, Mich., and Victor J. Roehm, Sebring Pottery Co., Sebring, Ohio.

COMMITTEE B NOMINATES OFFICERS FOR 1935–1936

J. T. Littleton, Chairman of Nominations Committee B, has announced the following nominations for officers of the Society for 1935–1936: *President:* J. M. McKinley, North American Refractories Co., Cleveland, Ohio; *Vice-President:* F. C. Flint, Hazel-Atlas Glass Co., Washington, Pa.; and *Treasurer:* H. B. Henderson, Beaver Falls, Pa.

ENAMEL DIVISION SUBCOMMITTEE ANNOUNCED

R. B. Schaal, *Chairman,* Roberts & Mander Stove Co., C. J. Kinzie, Titanium Alloy Mfg. Co., G. E. F. Lundell, National Bureau of Standards, and E. P. Poste, Consulting Engineer, comprise the Subcommittee on Standard Methods for Analysis of Enamels and Enamel Materials, which will function as a branch of the Enamel Division Committee on Standardization of Tests. This subcommittee has just been formed according to the announcement of W. N. Harrison, *Chairman,* Enamel Division.

PRODUCTIVENESS OF CARL HARROP

Carl Harrop was asked to accept the professional degree of Ceramic Engineer in June, 1931, with Edward Orton, Jr., Albert Bleininger, Wilber Stout, Frank Riddle, and John Martin, no one of whom had a collegiate degree in ceramics, yet each of whom had earned distinction by accomplishments and writings.[1]

Carl was a successful engineer because, based on factual relations, he could vision a construction or machine, put his vision onto tracing cloth, and then translate his vision and drawings into workable things.

That was the combination of an artist and an engineer; of a scientist and a practical operator; of a professional and a business executive. Carl's monuments are numerous constructions, patents, ideas, and inspired pupils which need not be here pictured or listed. They will endure beyond the memory of his contemporaries.

PUBLICATIONS BY CARL B. HARROP

"Design of a tile plant with a view to economical construction and operation," *Clay-Worker,* pp. 604–607 (April, 1913).

"Kiln expansion and bracing," *28th Ann. Rept. N.B.M.A.,* pp. 59–80 (1915).

"Inadequacy of static pressure draft gages," *Trans. Amer. Ceram. Soc.,* **18,** 223 (1916).

"Methods of calcining clay for grog," *ibid.,* pp. 165, 876.

"Heat balance of a continuous tunnel kiln," *ibid.,* **19,** 216–35 (1917).

"Increased efficiency through proper furnace construction," *Brick Clay Rec.,* pp. 583–87 (March 26, 1918).

"Principles and design of ceramic burners," *ibid.,* pp. 765–71 (April 23, 1918).

"Test of a producer gas-fired periodic kiln," *Jour. Amer. Ceram. Soc.,* **1** [1], 35–63 (1918).

"Continuous tunnel kiln," *ibid.,* **3** [9], 697–700 (1920).

"Continuous tunnel kilns at the plant of the Mt. Clemens Pottery Co., Mt. Clemens, Michigan," *ibid.,* **4** [8], 673–80 (1921).

"Stoker application to the car tunnel kiln," *ibid.,* **12** [6], 406–409 (1929) (in collaboration with H. S. Orth).

"Conservation of Fuel," *39th Ann. Rept. N.B.M.A.,* pp. 101–13 (1925).

"Tunnel kilns for heavy clay wares," *Rept., 24th Ann. Conv. Can. Nat. Clay Prod. Assn.,* 1926.

[1] See *Bull. Amer. Ceram. Soc.,* **10** [7] 197 (1931).

GLASS DIVISION SUMMER MEETING ATTENDED BY MORE THAN ONE HUNDRED

Ninety-eight members of the Glass Division attended the luncheon held at the Hammondsport Hotel Friday noon. The Friday night dinner was served to one hundred eight. One hundred sixteen were present Saturday noon at the luncheon at which F. M. Champlin talked on "The Chemistry of Wines."

Including the ladies present at the shore dinner at Willow Point Saturday night, over one hundred fifty attended. Fifty guests stayed at the Littleton cottages over Sunday.

Michael Parkin, representing W. E. S. Turner who was unable to attend the meeting, is to be seen seated in the first row in the above picture, eighth from the reader's left. The technical sessions were considered most successful, and the entertainment provided at Lake Keuka was enjoyed by all of the guests.

The general topic for this meeting was Chemical Durability. Twelve papers were read and discussed.

A bibliography of important literature on this topic was presented by the editors of *Glass Industry*, the first section of which is to be found on pages 187 to 191, September, 1934, issue of *Glass Industry*. This bibliography is concluded in the October issue of *Glass Industry*, pages 225 to 227.

For a detailed program of the Technical Sessions please see *The Bulletin*, p. 205 (August, 1934).

Glass Division Summer Meeting Roster

American Bottlers of Carbonated Beverages, J. H. Toulouse.
American Ceramic Society, Columbus, Ohio, Ross C. Purdy.
American Druggists Association, J. P. Snyder.
American Optical Co., Southbridge, Mass., E. D. Tillyer.
American Potash & Chemical Co., New York, N. Y., R. M. Curts.
Bailey & Sharp, Inc., Hamburg, N. Y., James Bailey, William Horak, and Donald E. Sharp.
Bausch & Lomb Optical Co., Rochester, N. Y., Murray R. Scott.
Buck Glass Co., Baltimore, Md., Roy Blunt.
Carr-Lowrey Glass Co., Baltimore, Md., Charles B. Garwood and C. B. McComas.
J. M. Case & Son, Reading, Pa., Paul Case.
Ceramic Industry, Chicago, Ill., H. V. Kaeppel.
Consolidated Feldspar Corp., East Liverpool, Ohio, H. B. DuBois; Trenton, N. J., V. V. Kelsey.
Corhart Refractories Co., Louisville, Ky., H. M. Baque and H. M. Kraner.
Corning Brick, Terra Cotta & Tile Co., Corning, N. Y., M. C. Gregory.
Corning Glass Works, Corning, N. Y., H. C. Bates, Frederick R. Carder, P. T. Clark, R. H. Dalton, R. K. Day, H. F. Eilers, E. M. Guyer, Kenneth E. Holley, H. P. Hood, J. C. Hostetter, J. C. Hostetter, Jr., F. Hyde, J. T. Littleton, George V. McCauley, M. E. Nordberg, William W. Oakley, Robert Sherwood, R. D. Smith, Guy E. Stong, E. C. Sullivan, W. C. Taylor, Alfred Vaksdal, and H. Wilson.
Dominion Glass Co., Hamilton, Ontario, Canada, I. L. Sills.
B. F. Drakenfeld & Co., New York, N. Y., R. R. Shively; Washington, Pa., B. H. Remington.
E. I. du Pont de Nemours & Co., Inc., Cleveland, Ohio, R. F. Brenner.
Fostoria Glass Co., Moundsville, W. Va., W. F. Curtis.
General Electric Co., Cleveland, Ohio, William M. Clark, G. E. Reinker, and Charles D. Spencer; Schenectady, N. Y., Louis Navias.
Glass Industry, New York, N. Y., John T. Ogden and J. C. Osmum.
Geophysical Laboratory, Washington, D. C., G. W. Morey.
Hartford-Empire Co., Hartford, Conn., E. O. Hiller and V. C. Swicker.
Hazel-Atlas Glass Co., Washington, Pa., Francis C. Flint and Aaron Lyle.
O. Hommel, Inc., Pittsburgh, Pa., Ernest M. Hommel and C. H. Turner.
International Mill Dealers Association, H. A. Tiebler.
Libbey-Owens-Ford Glass Co., Charleston, W. Va., W. F. Brown.
Macbeth-Evans Glass Co., Charleroi, Pa., D. O. Evans and H. W. Gillette.
Maryland Glass Co., Baltimore, Md., W. R. Lester and Louis C. Roche.
Massachusetts Institute of Technology, Cambridge, Mass., G. J. Bair.
Mellon Institute, Pittsburgh, Pa., Frank L. Jones, R. R. McGregor, E. Ward Tillotson, and Jack H. Waggoner.
National Bureau of Standards, Washington, D. C., Alfred N. Finn and Herbert Insley.
National Lead Co., St. Louis, Mo., P. E. Harth.
New York State College of Ceramics, Alfred, N. Y., Samuel R. Scholes and V. E. Wessels.
North American Refractories Co., Cleveland, Ohio, J. M. McKinley.
Onondaga Pottery Co., Syracuse, N. Y., Edward Schramm.
Owens-Illinois Glass Co., Alton, Ill., U. E. Bowes, O. G. Burch, and Joe W. Wright; Toledo, Ohio, R. W. Wampler.
Pass & Seymour, Inc., Syracuse, N. Y., F. P. Hall.
Pennsylvania State College, State College, Pa., Gordon Pole, Nelson W. Taylor, and F. J. Williams.
Pennsylvania Wire Glass Co., Dunbar, Pa., L. T. Sherwood and William Stevenson.
Pittsburgh Plate Glass Co., Creighton, Pa., W. A. Mahaffy and J. C. Parkinson; Pittsburgh, Pa., M. G. Babcock and R. A. Miller.
Pleasant Valley Wine Cellars, Hammondsport, N. Y., F. M. Champlin.
Sheffield University, Sheffield, England, Michael Parkin.
H. C. Spinks Clay Co., Newport, Ky., R. B. Carothers.
Universal Sanitary Mfg. Co., New Castle, Pa., W. Keith McAfee.
Urbania Wine Cellars, Hammondsport, N. Y., Eugene Crance and Charles Fournier.
Willson Products Co., Reading, Pa., E. L. Hettinger.
Individuals Attending: A. C. Barber, Butler, Pa., Don Brown, J. G. Callinan, 484 St. Clair Ave., Columbus, Ohio, S. S. Cole, 7 West Street, Hornell, N. Y., J. Faircomb, V. F. Fuller, Ed. Leibig, Alexis Pincus, Box 181, Hamburg, N. Y., F. W. Preston, Butler, Pa., and D. K. Wright.

LOS ANGELES WOMEN'S CLUB SPONSORS CERAMIC LECTURES

As a direct result of the summer lecture course outlined and presented by the California Section of the American Ceramic Society at the University of Southern California (see *The Bulletin*, pp. 207–208 (August, 1934)), the Women's Club of Los Angeles has requested a series of lectures and a permanent exhibit of locally made ceramic ware.

Local Sections of the American Ceramic Society in other parts of the country as well as ceramic trade associations throughout the nation may expect similar enthusiastic response to such a campaign.

The complete outline for a lecture course on Basic Ceramic Technology, intended to arouse the interest of students, designers, and laymen, as well as to point out the unique properties of many ceramic products is to be found in *The Bulletin*, p. 208 (August, 1934).

NOTES AND NEWS

FOUNDRY CONGRESS TO HEAR RENOWNED SCIENTISTS

The Fifth International Foundry Congress will be held in conjunction with the 28th Annual Convention of the American Foundrymen's Association in Philadelphia, Pa., October 22 to 26. Noted scientists have prepared papers which will be presented at these meetings.

Overseas foundrymen attending the Congress will have an opportunity to inspect examples of practically all phases of castings manufacture in the United States. A tour extending into the middle west as far as Chicago has been planned for the foreign visitors.

PENN STATE CERAMICS ADVISORY COMMITTEE PERSONNEL ANNOUNCED

The personnel of the Penn State Ceramics Advisory Committee, organization of which was reported in *The Bulletin*, p. 192 (July, 1934), is now as follows: *Chairman:* Roger W. Rowland, President, New Castle Refractories Co., New Castle, Pa.; *Secretary:* Nelson W. Taylor, Head, Dept. of Ceramics, Pennsylvania State College, State College, Pa.; Thomas Armstrong, President, Conkling-Armstrong Terra Cotta Co., Philadelphia, Pa.; Francis C. Flint, Director of Research, Hazel-Atlas Glass Co., Washington, Pa.; E. H. Fritz, Manager, Engineering Dept., Westinghouse Electric and Manufacturing Co., Derry, Pa.; J. C. Hostetter, Director of Research, Corning Glass Works, Corning, N. Y.; W. Keith McAfee, President, Universal Sanitary Mfg. Co., New Castle, Pa.; J. M. McKinley, Vice-President, North American Refractories Co., Cleveland, Ohio; and H. A. Plusch, Vice-President, Precision Grinding Wheel Co., Philadelphia, Pa.

ERRATUM

Contrary to the statement in *The Bulletin*, p. 215 (August, 1934), it is our pleasure to report that the Vitrefrax Corporation states through its Secretary, C. V. Knemeyer, that it has done more constructive development work in the past eighteen months than had been carried on in the previous three or four years.

GLASS MANUFACTURERS EXHIBIT AMERICAN WARE IN IOWA

Glassware from Cambridge, Fostoria, Morgantown, Westmoreland, and the Blenko Glass Co. has been placed in a loan collection which the Iowa Federation of Women's Clubs plans to exhibit the first of October.

Ten hand-made reproductions of early American glassware comprise the Blenko exhibit, a direct result of the appeal printed in *The Bulletin*, p. 113 (April, 1934).

The September-October issue of the *Iowa Club Woman*, published at Des Moines, circulation 30,000, has just carried the announcement of this new loan collection to every club member in the Iowa Federation. First engagement of the loan collection is at Keokuk, Iowa, October 3, for the annual convention of federated clubs of Lee County.

Stimulation of interest among American users of glassware in the artistic and superior glassware designed and manufactured by American glass companies is one profitable result of coöperation with club exhibits of this sort.

New uses of glassware as decorative additions to table settings may also be demonstrated through appropriately chosen exhibits loaned to such collections.

Other American companies invited to exhibit are expected to add their glassware to this collection soon.

Mrs. Anna Lane Dixon, Burlington, Iowa, in charge of pottery and glass activities for the Iowa Federation of Women's Clubs, has for several years enthusiastically championed American-made ceramic products.

Her traveling exhibits, lecture outlines, and bibliographies on American pottery and glass are much appreciated by the club women of Iowa.

A brief bibliography on glass follows. Suggestions and further material for this bibliography will be welcome. She is also seeking aid in preparing bibliographies on all kinds of ceramic ware, with especial interest at the moment centered about pottery.

BIBLIOGRAPHY FOR STUDY OF AMERICAN GLASS[1]

(1) How It Is Made, by Archibald Williams. Thomas Nelson & Sons, London, Edinburgh, Dublin (not dated).

(2) Fifty Years of Glassmaking. Macbeth-Evans Glass Co., Charleroi, Pa.

(3) Window Glass in the Making, by William L. Monro. American Window Glass Co., Pittsburgh, Pa., 1926.

(4) Wonders of Glassmaking, by Alexander Sauzay. Charles Scribner's Sons, 1885.

(5) Early American Craftsmen, Chap. 7, by Walter Dyer. Century Co., 1915.

(6) Early American Glass, by Rhea Mansfield Knittle. Century Co., 1927.

(7) Early American Pressed Glass, by Ruth Webb Lee. Pub. by the author, Pittsfield, N. Y. Printed by Ferris Pub. Co., New York, 1932.

(8) Sandwich Glass, by F. T. Irwin, a workman in the factory. Pub. Manchester, N. H.

(9) Old Glass, by N. Hudson Moore. Frederick A. Stokes, New York, 1932.

(10) Collector's Luck, Chap. 8, by Alice Van Lear Carrick. Atlantic Monthly Press.

(11) Old Beautiful, by Thomas Rohan ("Pontil"), Lincoln McVeagh, The Dial Press, New York.

(12) Old Glass Beautiful, by Thomas Rohan. Mills & Boon, Ltd., London W. 1, 1930.

(13) Spanish Arts (The Industrial Arts of Spain), by Juan F. Riano. Chapman & Hall, Ltd., London, 1890.

(14) The Arts and Crafts of Older Spain, by Leonard Williams. Pub. by T. N. Foulis, 23 Bedford St., London, W. C., 1907.

(15) Lecture on Glass, by Lillian Bolick, Professor of Chemistry, Duke Univ., Durham, N. C.

[1] By Anna Lane Dixon, Curator of American Pottery, Porcelain, and Glass for the Fine Arts Committee, Iowa Federation of Women's Clubs, Burlington, Iowa.

(16) From *Crockery & Glass Journal.*
  (*a*) "Cambridge Glass," Oct., 1929.
  (*b*) "Stiegel Glass," Dec., 1930.
(17) *China, Glass, & Lamps.*
  (*a*) "Manufacture of Table Glassware," April 8, 1929.
  (*b*) "Durand Glass," Sept., 1929.
  (*c*) "English Crystal," Sept., 1929.
  (*d*) "Old Waterford Reproductions," Sept., 1930.
  (*e*) "Waterford Glass," March 25, 1929.
  (*f*) "Milk Glass," March 25, 1929.
  (*g*) "Romance of French Crystal," April, 1930.
  (*h*) "Carved Glass," Oct., 1930.
  (*i*) "Early American Glass Club," Jan., 1934.
(18) Other magazines, *i.e., House Beautiful, Good Housekeeping, Antiques*, etc.

ILLINOIS CONFERENCE ON GLASS PROBLEMS TENTATIVE PROGRAM ANNOUNCED

"The Use of Glass Cullet," "Some Problems and Perplexities in the Glass Industry," "Observations on Heating a New Tank," "Batch Constituents and Their Effect on the Durability of Glass," "Fuel Oil *vs.* Producer Gas in Glassmelting," "Practical Tank Operation," and "Changes in the Elastic Properties of Glass as Affected by Temperature" are among the titles of papers announced in the tentative program of the Conference on Glass Problems to be held at the Dept. of Ceramic Engineering, University of Illinois, Urbana, Illinois, November 2 and 3.

Other features and any additional papers will be announced in the program to be mailed in advance of the meeting to persons requesting it. Requests for copies of this program will receive prompt attention if addressed to C. W. Parmelee, Dept. of Ceramic Engineering, University of Illinois, Urbana, Ill.

Those planning to attend the Conference are asked to send requests for room reservations direct to the Dept. of Ceramic Engineering in advance since the Army-University of Illinois football game on Saturday, November 3, will bring a large crowd of visitors to Urbana.

OHIO CERAMIC INDUSTRIES ASSOCIATION FALL MEETING PROGRAM

Titles of the papers on the tentative program of the Ohio Ceramic Industries Association fall meeting, to be held November 16 and 17 at Ohio State University, have just been announced.

This meeting is scheduled for the week-end of the Michigan-Ohio State football game, and as usual a block of seats is reserved for the visiting ceramists. These may be obtained from the office of the Association, Lord Hall, Ohio State University, Columbus, Ohio, at $3.00 each, tax included.

A complimentary luncheon will be given Saturday noon on the second floor of the Engineering Experiment Station Building to all ceramists and their ladies attending these meetings, and to all former students of Ohio Ceramic Engineering and Ceramic Arts Departments. The purposes of this luncheon are (1) social, (2) to avoid crowded restaurants, and (3) to be near the stadium.

The following incomplete program is of course subject to revision:

General Interest

"Metal Wear Investigation," by J. O. Everhart

Heavy Clay Products

"De-airing a Sewer Pipe Press," by J. O. Everhart
"Fillers for Brick Roads," by W. C. Rueckel
"Pulverized Clay or Shale in Low Strength Mass Concrete," by J. R. Shank

Refractories

"A Method for De-airing a Dry Press," by G. A. Bole
"Microscopic Methods Used in the Study of Refractories," by W. J. McCaughey
"A Microscopic Study of Olivine and Serpentine Refractories," by E. A. Durbin

Whiteware

"A New Lining Compound," by G. A. Loomis
"A Symposium on Spit-Out," by A. S. Watts

Enamel

"The Plan, Purpose, and Accomplishments of the Educational Bureau of the Porcelain Enamel Institute," by E. L. Lasier
"Which Way, the Enameling Industry?" by Earle S. Smith
"Should Ohio Enamelers Meet for Discussion of Problems?" by Charles S. Pearce
"What the Ohio Ceramic Industries Association Has to Offer an Enamelers' Section," by H. E. Nold

Discussions

PRIMITIVE GLASSWORKING DEMONSTRATED AT FAIR

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B

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McDanel Refractory Porcelain Co.

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Pacific Coast Borax Co.

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C

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D

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E

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Porcelain Enamel & Mfg. Co.

Exolon (Refractory Products)
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F

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Porcelain Enamel & Mfg. Co.

G

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H

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(*Carbofrax* heat treating)
Norton Co. (*Crystolon*)

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I

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K

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L

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M

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The Vitro Mfg. Co.

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Drakenfeld & Co., B. F.
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The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Muffles (Furnace)
Carborundum Co. (*Carbofrax*)
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Ferro Enamel Corp.
Norton Co.

Mullite (Artificial)
The Exolon Co.

Muriatic Acid
The Hommel Co., O., Inc.

N

Nitrates (Cobalt, Sodium)
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The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

O

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Metal & Thermit Corp.
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Oxides
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Ferro Enamel Corp.
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P

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R

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Norton Co.

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The Exolon Co.
Norton Co.
Titanium Alloy Mfg. Co.

Rutile
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Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

S

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.

Selenite of Sodium
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Selenium
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sheets (Enameling Iron)
American Rolling Mill Co.

Silica (Fused)
The Exolon Co.

Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Philadelphia Quartz Co.
The Vitro Mfg. Co.

Silicon Carbide
The Exolon Co.
Norton Co.

Silicon Carbide Firesand
The Exolon Co.

Sillimanite (Synthetic)
The Exolon Co.

Slabs (Furnace)
Carborundum Co.
Norton Co.

Smelters
Ferro Enamel Corp.
The Hommel Co., O., Inc.
Porcelain Enamel & Mfg. Co.

Soda Ash
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sodium Fluoride
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Spar
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Spurs
Potters Supply Co.

Stilts
Potters Supply Co.

Sulphuric Acid
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.

BUYERS' GUIDE (continued)

T

Talc
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.

Tanks (Pickle)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
The Hommel Co., O., Inc.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Norton Co.

Tile (Wall)
Ferro Enamel Corp.
The Hommel Co., O., Inc.

Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Titanium Oxide
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Norton Co.

Tubes (Pyrometer)
McDanel Refractory Porcelain Co.
Norton Co.

W

Wet Enamel
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
The Hommel Co., O., Inc.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Whiting
Drakenfeld & Co., B. F.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.

Z

Zirconia
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

McDANEL REFRACTORY PORCELAIN COMPANY
Manufacturers of
PORCELAIN TUBES PROTECTION TUBES
INSULATING TUBING and BEADS
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Chattanooga, Tenn.

IMPORTANT DEPOSITS OF
VOLCANIC ASH, SILICA, PUMICE, etc.
For Sale by Tender
Pursuant to an Order of the Court dated August 14, 1934, tenders will be called for by the Liquidator for the assets and undertaking of Van-Kel Cleansers, Ltd., Swift Current, Sask.
In addition to a modern plant, machinery and equipment, etc., the assets include title to 160 acres of land containing deposits of Volcanic Ash, Silica and Pumice, etc.—also quarrying and clay leases covering 140 acres of land containing similar deposits.
Write today for complete details of property and instructions relative to tendering.
THE CANADA PERMANENT TRUST COMPANY
Regina, Sask. Liquidator

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WILLSON PRODUCTS, Inc. Reading, Pa.

ALPHABETICAL LIST OF ADVERTISERS

	Page
Allied Engineering Co.	14
American Potash & Chemical Corp.	Inside Back Cover
Bethlehem Steel Co.	13
Bonnot Co.	11
Buyers' Guide	8
Ceramic Color & Chemical Mfg. Co.	3
Chicago Vitreous Enamel Product Co.	7
Corhart Refractories Co., Inc.	4
Du Pont de Nemours, E. I., & Co., Inc.	15
Edgar Bros. Co.	2
Edgar Plastic Kaolin Co.	2
Exolon Co.	Inside Back Cover
Ferro Enamel Corp.	3
Hammill & Gillespie, Inc.	7
Hartford-Empire Co.	14
Hommel, O., Co., Inc.	12
Hotel Statler (Activities)	283
Journal Society of Glass Technology	6
Jungmann & Co., Inc.	Inside Back Cover
McDanel Refractory Porcelain Co.	10
Metal & Thermit Corp.	Outside Back Cover
Pacific Coast Borax Co.	6
Paper Makers Importing Co.	7
Philadelphia Quartz Co.	2
Pittsburgh Plate Glass Co.	12
Porcelain Enamel & Mfg. Co.	2
Potters Supply Co.	14
Professional Directory	10
Roessler & Hasslacher Chemical Co.	15
Simplex Engineering Co.	5
Spinks, H. C., Clay Co.	16
Standard Pyrometric Cone Co.	3
Tables Annuelles de Constantes	12
The Canada Permanent Trust Co.	10
Titanium Alloy Mfg., Co.	Inside Front Cover
Vitro Mfg. Co.	6
Willson Products, Inc.	10
Wilson, H. W., Co.	6

BONNOT SUPERIOR DE-AIRING PLEASES THE LEADERS

The following summarized statements are from leading manufacturers in various lines covering their use of *Bonnot Vacuum Process Equipment.*

SEMI-VITREOUS TABLEWARE: "The use of your de-airing equipment IMPROVES OUR BODY TO A MARKED EXTENT . . . and renders the making or jiggering of the ware much easier. By reason of the improved quality of the ware and the much better workability of our material and the satisfaction of our jiggerman in handling the de-aired body, etc. . . . we think this equipment represents a VERY IMPORTANT DEVELOPMENT."

ELECTRICAL PORCELAIN SPECIALITIES: "Please be advised that the Bonnot De-Airing Unit which we purchased from you some time ago is ENTIRELY SATISFACTORY . . . and we are very pleased with the results we are obtaining from this machine."

VITRIFIED HOTELWARE: "We believe that the de-airing process is DECIDEDLY WORTH WHILE. It makes the jiggering much easier, the fired ware straighter; it reduces losses. . . . We are very MUCH PLEASED WITH THE EQUIPMENT, BELIEVE IT A MAJOR DEVELOPMENT in clay making—IN FACT THE GREATEST development since the introduction of pebble mills for vitrified china."

SPARK PLUGS: "De-Airing is certainly worth while to us as we COULD NOT OPERATE WITHOUT IT. . . . The advantages your machine offer are ESSENTIAL and we would certainly state that the de-airing of ceramic bodies is THE OUTSTANDING DEVELOPMENT in body preparation over many years and your particular machine ACHIEVES THE DESIRED RESULTS EXCEEDINGLY WELL."

Submit your requirements. Without obligation we shall gladly present our suggestions for betterment of your process and products.

THE BONNOT COMPANY
CANTON, OHIO
Since 1891

Products of

PROVEN QUALITY

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OHCO Non-Porus Porcelain Balls and Bricks

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209 FOURTH AVENUE, PITTSBURGH, PA.
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SINCE 1891

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Refractory Blocks
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Prepared Mixes
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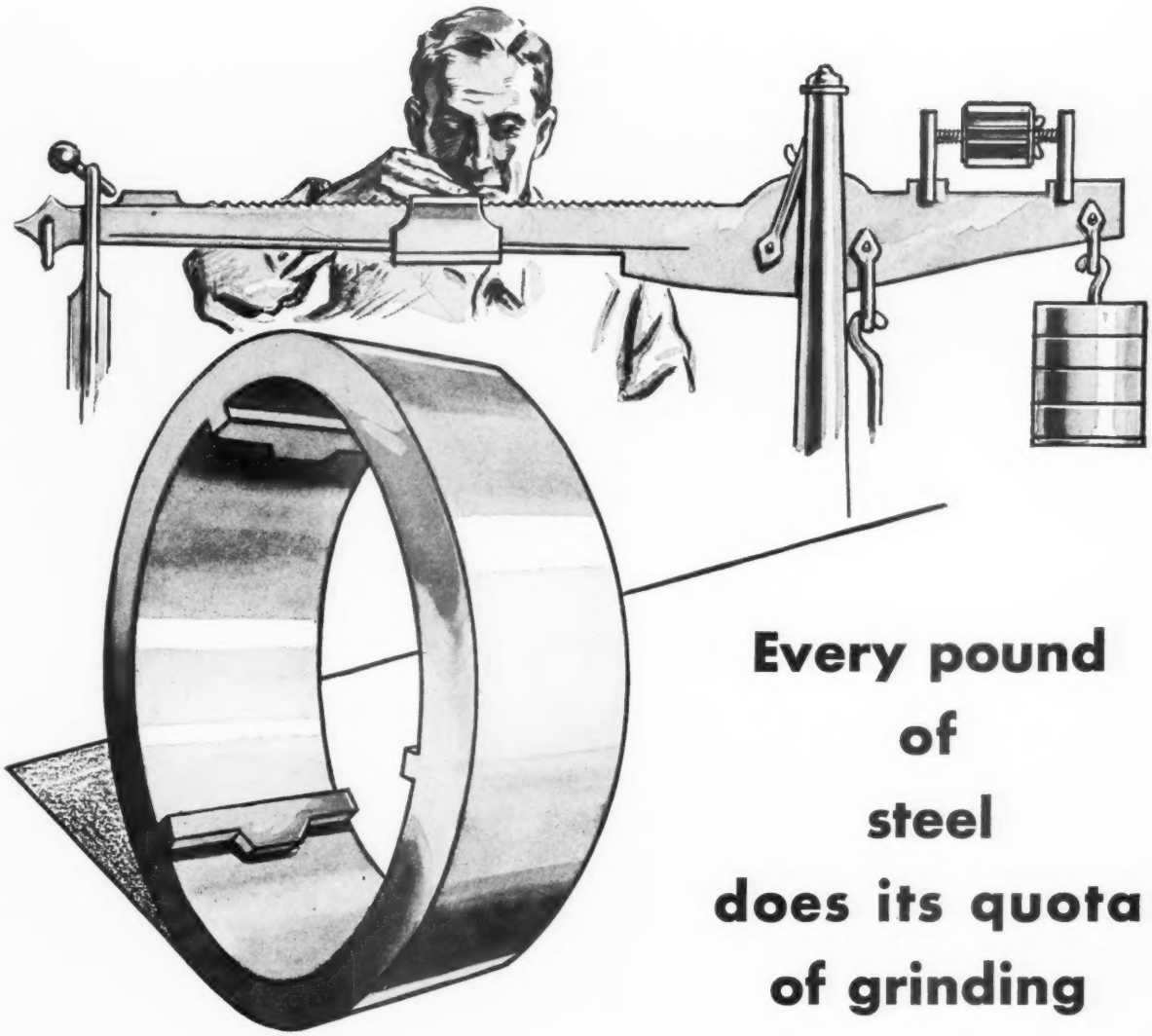

Every pound of steel does its quota of grinding

WHEN you use Bethlehem 88-80 Castings for the parts of grinding, crushing and pulverizing machinery that bear the brunt of abrasive wear, you get an exceptional combination of characteristics that make for long life.

Foremost, of course, are the high abrasive-resisting properties of 88-80 Castings that are adapted to the particular material to be ground by special heat-treatment.

But of equal importance is the fact that the remarkable wear-resistance of 88-80 extends all the way through the castings. There's no relatively soft center under a hard surface. Every pound of steel you buy grinds its quota of material. Furthermore, the surface wears evenly without developing a hollow center that consumes power and cuts down the output of machines. Neither are there any too-hard corners to break off, nor soft spots to wear into pockets.

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BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

District Offices: Atlanta, Baltimore, Boston, Bridgeport, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, Indianapolis, Milwaukee, New York, Philadelphia, Pittsburgh, St. Louis, St. Paul, Washington, Wilkes-Barre, York. *Pacific Coast Distributor:* Pacific Coast Steel Corporation, San Francisco, Seattle, Los Angeles, Portland, Honolulu. *Export Distributor:* Bethlehem Steel Export Corporation, New York.

BETHLEHEM STEEL

BETHLEHEM 88-80 CASTINGS

HARTFORD-EMPIRE COMPANY
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(A SUBSIDIARY OF FERRO ENAMEL CORPORATION, CLEVELAND, O.)

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Stilts
Thimbles
Spurs
Saggers
Crucibles
Tile for Decorating Kilns

We Sell—
Ball Clay
Sagger Clay
Wad Clay
Ground Fire Clay
Bitstone
Fire Brick
Imported Paris White
Domestic Whiting

THE POTTERS SUPPLY COMPANY
EAST LIVERPOOL, OHIO

BORDEN'S ADOPTS COLORED CREST TO INTRODUCE NEW GRADE OF MILK

•

R & H Ceramic Colors Selected for Decorating Bottles

NOVEL in the use of color on milk bottles is the brand identification — a shield supporting the profile of a cow, colored in red and gold—adopted by the Borden's Farm Products Company, Inc. to aid in introducing its new Grade A "Golden Crest" Milk to the New York market during June. The name "Borden's" also appears in color just below the shield.

The design adopted by Borden's is a distinctive advance in the use of color on milk bottles. To secure the necessary effect it was found that special ceramic colors would be required. Only colors resistant to alkali could be used to prevent fading of color when the milk bottles were washed and sterilized.

The R. & H. Chemicals Department of the du Pont Company was glad to cooperate in developing the special red and gold colors required. The colors finally selected by Borden's were prepared at the R & H Ceramic Laboratory at Perth Amboy, New Jersey, especially for this decoration problem. The colors developed are alkali resistant.

Borden's Farm Products Company, Inc. placed an initial order for 50 carloads of these bottles so that they could start off with a complete supply and also have a sufficient reserve for replacement. To date they have found that the new decorated bottle has been a strong merchandising help in introducing the new "Golden Crest" milk. The milk and the new container are being advertised to the metropolitan market through newspapers, car cards, outdoor posters, wagon posters, bottle slipovers and other mediums.

BORDEN'S FARM PRODUCTS CO. INC
NEW YORK
June 11, 1934.
Mr. Thos. H. McKeown
E. I. du Pont de Nemours & Co., Inc.
The R. & H. Chemicals Dept.
Front & Commerce Sts.
Perth Amboy, N. J.
Dear Mr. McKeown:
Enclosed is our second ad following the introduction
of our new Grade A "Golden Crest" Milk, which was made Thursday, June
7th. I take this opportunity of expressing our appreciation for the
cooperation you have given us in working out suitable colors for this
new bottle. Judging from the unsolicited comments we have received,
this new package will have a very favorable consumer acceptance.
Very truly yours,
Vice President.
Encl.
Borden's

* * *

Mr. J. F. Watson, Vice-President of Borden's Farm Products Company, Inc., writes as follows:

> **"Enclosed is our second ad following the introduction of our new Grade A 'Golden Crest' Milk, which was made Thursday, June 7th. I take this opportunity of expressing our appreciation for the cooperation you have given us in working out suitable colors for this new bottle. Judging from the unsolicited comments we have received, this new package will have a very favorable consumer acceptance."**

The R. & H. Chemicals Department of the du Pont Company will be glad to cooperate with decorators or purchasers of decorated ceramic materials in selecting R & H Colors for particular purposes. A wide variety of R & H Chemicals and Colors is available for glassware, dinnerware, pottery, tile, heavy clay products and porcelain enamels.

Write us about your requirements.

DU PONT

R&H Chemicals and Colors

REG. U.S. PAT. OFF.

THE R. & H. CHEMICALS DEPT., E. I. DU PONT DE NEMOURS & COMPANY, Inc.
Ceramic Section — Perth Amboy, New Jersey
District Sales Offices: BALTIMORE · BOSTON · CHARLOTTE · CHICAGO · CLEVELAND · KANSAS CITY
NEWARK · NEW YORK · PHILADELPHIA · PITTSBURGH · SAN FRANCISCO

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Miners and Shippers of
BALL, SAGGAR AND WAD CLAY
NEWPORT, KY.

Gleason, Tennessee
October 10, 1934

Mr. R. B. Carothers, Gen. Mgr.
H. C. Spinks Clay Company
Newport, Kentucky

Dear Dick:

We have 10,000 tons of clay in our storage sheds. Each of the sheds will hold some more clay, and we will continue mining until bad weather stops us.

With this 10,000 tons of clay in the sheds, our customers are sure of getting prompt shipments of uniform shed dried clay during the winter months.

This is such a fine asset that I think you ought to tell the trade about it.

Sincerely yours,

Clayton

Sup't. of Mines

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70 Pine Street, New York

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FUSED ALUMINUM OXIDE
FUSED MAGNESITE

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Sodium Antimonate

For years M & T Sodium Antimonate has set the standard. The finest opacifier that modern methods can produce, it is always uniform, always pure. Every barrel of M & T Sodium Antimonate is exactly the same, both chemically and physically, as every other barrel.

And, this quality opacifier is more economical. Rejects, due to off colors, become rarities. Whites, whether blue white, cream white or some other hue, do not vary a shade from one year's end to the next where M & T Sodium Antimonate is used.

Our Ceramic Department will gladly help in solving your enameling problems. Homer F. Staley is manger; R. R. Danielson, director of research. Metal & Thermit Corporation, 120 Broadway, New York, N. Y.